

Bond University

DOCTORAL THESIS

Malnutrition in the older Australian rural rehabilitation community : identification, patient outcomes and the role of informal caregivers,

Marshall, Skye

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MALNUTRITION IN THE OLDER AUSTRALIAN RURAL REHABILITATION COMMUNITY:

IDENTIFICATION, PATIENT OUTCOMES AND THE ROLE OF INFORMAL CAREGIVERS

A thesis submitted in total fulfilment of the
requirements of the degree of Doctor of Philosophy by
Publication

by
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ABSTRACT

Background and literature review

Enhancing the effectiveness of nutritional care to improve the overall health of older adults will be key in reducing hospital and aged care facility demand, a priority target of current health service research and policy. Engaging informal caregivers as part of the nutrition care team presents an opportunity for improving the nutrition status of older Australians in rehabilitation and the community. Rehabilitation facilities have the highest prevalence of malnutrition (5 – 68%); which is negatively associated with physical function and quality of life, and positively associated with risk of admission to residential aged care (RAC), hospitalisation and mortality following discharge to the community. However, there is insufficient evidence for informing best practice in identifying malnutrition in the rehabilitation setting and providing nutrition support to patients as they transition back to the community. Importantly, it is not known if patients remain malnourished following-discharge from rehabilitation. The aim of this thesis is to increase the evidence-base for improving the nutrition status of older adults in rural Australia across the continuum of care and exploring the role of caregivers in supporting nutrition-related care during the transition from rehabilitation to home.

Methods

Therefore, the MARRC Study (Malnutrition in the Rural Rehabilitation Community) was undertaken, which comprised a prospective observational cohort study and a qualitative study. The cohort study recruited 57 malnourished older adults with informal caregivers from two rural rehabilitation units, and followed patients throughout rehabilitation and three months post-discharge. The prospective data was used to evaluate the criterion (concurrent and predictive) validity of two nutrition screening tools and two nutrition assessment tools compared to the ICD-10-AM classification of malnutrition. The prevalence of malnutrition and associated long-term patient outcomes were also reported. The change in nutrition status, quality of life and physical function of the malnourished patients over the study period was reported using a linear mixed model. The qualitative study recruited four female informal caregivers of malnourished older rehabilitation patients, who were interviewed during their care-recipients' rehabilitation admission and two weeks post-discharge. The interviews were analysed reflecting an interpretative phenomenological approach and a series of “drivers” relevant to the research question were discussed.

Results and conclusions

The Malnutrition Screening Tool and the Scored Patient-Generated Subjective Global Assessment tool have strong criterion validity and are appropriate for use in geriatric rehabilitation. Other nutrition screening tools and nutrition assessment tools require further examination or modification before they can be recommended. The prevalence of malnutrition was 46%, which is similar to metropolitan facilities. However, malnourished rehabilitation patients were more likely to be discharged to RAC and readmitted to hospital. These patients were found to have continuing malnutrition, low quality of life and worsening physical function for at least three months in their homes following their discharge from rehabilitation. The qualitative study identified three drivers: “responsibility”, “caregiver nutrition ethos”, and “quality of life”, and concluded that rehabilitation dietitians should recognise and support informal caregivers of malnourished patients. The current thesis provides evidence to improve malnutrition screening, assessment, diagnosis and resource allocation in rehabilitation facilities. It also makes recommendations to improve nutrition intervention in practice, and for how intervention studies should be designed in this setting. The thesis concludes with a call to action: for dietitians to advocate for malnutrition to be of higher consideration on the rehabilitation agenda, so that patient outcomes may be improved in the long term.

DECLARATION AND APPENDENDUM

This thesis is submitted to Bond University in fulfilment of the requirements of the degree of Doctor of Philosophy by Publication. This thesis represents my own original work towards this research degree and contains no material that has previously been submitted for a degree or diploma at this University or any other institution, except where due acknowledgement is made.

I affirm that the above statement of contribution is accurate:

Skye Marshall
29 January 2016

i. Signed statements of contribution by all co-authors of publications which form a part of this thesis

Collaborative work has been undertaken for six publications which form a part of this thesis.

Marshall S, Bauer J, Capra S, Isenring E. (2013) Are informal carers and community care workers effective in managing malnutrition in the older adult community? A systematic review of current evidence. *The Journal of Nutrition, Health & Aging* 17, 645-651

Skye Marshall carried out the literature review, data extraction, review of study quality and strength, data analysis, interpretation of data, drafting and revision manuscript; Judith Bauer and Elizabeth Isenring reviewed study quality and strength and provided supervision; and Sandra Capra, Judith Bauer and Elizabeth Isenring provided guidance and revision of the manuscript.

I affirm that the above statement of contribution is accurate:

Skye Marshall

Judy Bauer

Sandra Capra

Elisabeth Isenring

Marshall, S., Bauer, J., Isenring, E. (2013) The consequences of malnutrition following discharge from rehabilitation to the community: A systematic review of current evidence in older adults. *Journal of Human Nutrition and Dietetics*, 27: 133-141.

Skye Marshall carried out the literature review, data extraction, review of study quality and strength, data analysis, interpretation of data, drafting and revision manuscript; Elizabeth Isenring reviewed study quality and strength. Judith Bauer and Elizabeth Isenring provided supervision, guidance and revision of the manuscript.

I affirm that the above statement of contribution is accurate:

Skye Marshall

Judy Bauer

Elisabeth Isenring

Marshall S, Young A, Bauer J, Isenring E. Nutrition screening in geriatric rehabilitation: Criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and the Mini Nutritional Assessment-Short Form (MNA-SF). *Journal of the Academy of Nutrition and Dietetics*. 2015;In Press.

Skye Marshall carried out the data collection, conducted the statistical analysis and interpretation of data, and drafted and revised the manuscript. Judith Bauer, Adrienne Young and Elizabeth Isenring provided supervision, guidance and revision of the manuscript.

I affirm that the above statement of contribution is accurate:

Skye Marshall

Adrienne Young

Judy Bauer

Elisabeth Isenring

Marshall S, Young A, Bauer J, Isenring E. Malnutrition in geriatric rehabilitation: prevalence, patient outcomes and criterion validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA) *Journal of the Academy of Nutrition and Dietetics*. 2015;In Press.

Skye Marshall carried out the data collection, conducted the statistical analysis and interpretation of data, and drafted and revised the manuscript. Elizabeth Isenring contributed to data checking. Judith Bauer, Adrienne Young and Elizabeth Isenring provided supervision, guidance and revision of the manuscript.

I affirm that the above statement of contribution is accurate:

Skye Marshall

Adrienne Young

Judy Bauer

Elizabeth Isenring

Marshall S, Young A, Bauer J, Isenring E (2015) Malnourished older adults admitted to rehabilitation in rural New South Wales remain malnourished throughout rehabilitation and once discharged back to the community: a prospective cohort study. *Journal of Aging Research and Clinical Practice*, 4(4), 197-204. DOI: 10.14283/jarcp.2015.72

Skye Marshall carried out the data collection, conducted the statistical analysis and interpretation of data, and drafted and revised the manuscript. Elizabeth Isenring contributed to data checking. Judith Bauer, Adrienne Young and Elizabeth Isenring provided supervision, guidance and revision of the manuscript.

I affirm that the above statement of contribution is accurate:

Skye Marshall

Adrienne Young

Judy Bauer

Elizabeth Isenring

Marshall S. Protein-energy malnutrition in the rehabilitation setting: evidence to improve identification. *Maturitas*, In Press. DOI: 10.1016/j.maturitas.2016.01.014.

Skye Marshall developed the study concept and carried out the literature review, data analysis, interpretation of data, drafting and revision of the manuscript as a sole author.

I affirm that the above statement of contribution is accurate:

Skye Marshall

Marshall S, Reidlinger D, Young A, Isenring E (2016) The food and nutrition-related roles, experiences and support needs of female informal caregivers of malnourished older rehabilitation patients. *Currently under review at The Gerontologist*.

Skye Marshall carried out the data collection, conducted the analysis and interpretation of data, and drafted the manuscript. Elizabeth Isenring and Dianne Reidlinger contributed to data analysis. Skye Marshall, Dianne Reidlinger, Adrienne Young and Elizabeth Isenring contributed to the study concept, study design and revision of the manuscript.

I affirm that the above statement of contribution is accurate:

Skye Marshall

Dianne Reidlinger

Adrienne Young

Elizabeth Isenring

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“The doctor of the future will no longer treat the human frame with drugs, but rather will cure and prevent disease with nutrition.” ~Thomas Edison

The first thing they tell you when you commence a PhD is that “it will never turn out the way you first imagine it”. I’ve got to say, this has been perfectly true for my doctoral research. But for that, I’m so glad! Despite several big changes in my personal circumstances throughout my PhD candidature, including moving states twice and having a baby, my PhD supervisors and research team have provided enduring and flexible support, with the outcome that the process has been immensely enjoyable and fruitful.

To Liz Isenring, my primary supervisor, I am immensely grateful, and consider myself just plain lucky to have landed such a great supervisor, mentor and friend. To Adrienne Young, my associate supervisor, and Judy Bauer, former associate supervisor, I am also extremely grateful for the time, encouragement and quality you have provided my research. I am very proud of the seven publications that my PhD research has produced, and I am acutely aware that these would not exist, nor with such high quality, without the unique contributions and expertise of each of you. The members of Bond University Nutrition & Dietetics Research Group all contributed their time and energies to improve the quality of my research, publications and presentations, and for this I am very grateful. In particular, I would like to acknowledge the large contributions of Dianne Reidlinger, Katrina Campbell and Cherie Hugo. I also acknowledge the great pleasure of working with non-Bond University researchers as co-authors, Ekta Agarwal, Michelle Miller and Sandra Capra. And finally, thank you to Evelyn Rathbone, the Bond University statistician who gave me confidence in my numbers.

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I would like to thank the institutions who have provided me funding and support throughout my PhD candidature, and who chose to support my work in a competitive environment. I acknowledge the Australian Government for their support of Australian researchers through funding the Australian Postgraduate Award. I would like to thank the University of Queensland who first identified me as a worthy PhD scholar, and Bond University for continuing that support. I would also like to thank Bond University's Associate Dean of Research, Donna Sellers, for providing me additional research funding to support my participation in national and international conferences. I also acknowledge the Dietitians Association of Australia, and thank them for their contribution to my research-related travel expenses so that I could present at an allied health conference.

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TABLE OF CONTENTS

ABSTRACT	ii
DECLARATION AND APPENDENDUM.....	iv
i. Signed statements of contribution by all co-authors of publications which form a part of this thesis	iv
ACKNOWLEDGEMENTS	viii
TABLE OF CONTENTS	x
LIST OF PUBLICATIONS RELEVANT TO THE THESIS	xvi
ii. List of manuscripts published in peer-reviewed journals	xvi
iv. List of published conference abstracts.....	xviii
LIST OF PRESENTATIONS RELEVANT TO THE THESIS	xx
v. List of oral presentations relevant to the thesis.....	xx
vi. List of poster presentations relevant to the thesis	xxii
LIST OF FIGURES AND TABLES	xxiv
vii. List of figures.....	xxiv
viii. List of tables	xxv
LIST OF ABBREVIATIONS	xxvi
OUTLINE OF THESIS	xxviii
ix. Part 1: Introduction	xxviii
x. Part 2: Systematic Literature Reviews	xxviii
xi. Part 3: Malnutrition in the Older Australian Rural Rehabilitation Community	xxix
xii. Part 4: Conclusion	xxx
PART I: INTRODUCTION	1
CHAPTER 1: THE AUSTRALIAN AGEING POPULATION AND ASSOCIATED DEMANDS ON CARE DELIVERY	3
1.1 An ageing Australia	5
1.1.1 Defining older adults.....	6
1.2 Aged care delivery in Australia	6
1.2.1 Australian aged care programs and services	8
1.2.2 Changes to Australian aged care programs and services since 2013	9
1.2.3 Geographical challenges of service delivery in Australia.....	10
1.2.4 Aged care workforce	12
1.2.5 Role of the non-clinical aged care worker	12
1.3 Caring for ageing Australians	13

1.3.1 Informal care for older adults.....	13
1.3.2 The role of rehabilitation in supporting the ageing community.....	14
1.4 Nutritional concerns in older adults.....	15
1.4.1 Informal caregivers' influence on the nutrition status of older adults	15
1.5 Summary and proposed framework.....	17
CHAPTER 2: PROTEIN-ENERGY MALNUTRITION	19
2.1 Defining malnutrition	21
2.1.1 Malnutrition or starvation?.....	21
2.1.2 Malnutrition or sarcopenia?	22
2.1.3 Malnutrition or cachexia?.....	26
2.2 Aetiology of malnutrition	27
2.2.1 Impaired intake.....	27
2.2.2 Altered metabolic requirements	27
2.2.3 Impaired digestion and/or absorption.....	28
2.2.4 Excessive nutrient losses.....	28
2.2.5 Psychosocial risk factors for malnutrition.....	28
2.3 Physiological and psychosocial consequences of malnutrition	29
2.3.1 Physiological consequences of malnutrition.....	29
2.3.2 Psychosocial consequences of malnutrition.....	30
2.4 Economic consequences of malnutrition	31
2.5 Identifying and diagnosing malnutrition.....	32
2.5.1 Malnutrition screening	32
2.5.2 Malnutrition assessment.....	33
2.5.3 ICD-10-AM.....	34
2.5.4 Body mass index	34
2.6 Malnutrition prevalence in older adults in Australia and internationally	36
2.6.1 Malnutrition prevalence in acute care	37
2.6.2 Malnutrition prevalence in residential aged care	37
2.6.3 Malnutrition prevalence in rehabilitation.....	38
2.6.4 Malnutrition prevalence in the community	41
2.7 Treating malnutrition	44
2.7.1 Role of the dietitian in the multidisciplinary team.....	44
2.7.2 Evidence for the treatment of malnutrition in the rehabilitation and community settings	44
2.7.3 Evidence for the treatment of malnutrition in residential aged care	46

2.8 Conclusion	48
PART II: SYSTEMATIC LITERATURE REVIEWS	51
CHAPTER 3: CAREGIVER NUTRITION EDUCATION AND ITS EFFECT ON CARE-RECIPIENT AND CAREGIVER OUTCOMES	53
3.1 Preliminary exploratory literature review	55
3.1.1 Search strategy	55
3.1.2 Selection strategy and procedures	55
3.1.3 Quality assessment	55
3.1.4 Results and discussion.....	63
3.2 Are informal caregivers and community care workers effective in managing malnutrition in the older adult community? A systematic review of current evidence	64
3.2.1 Introduction	64
3.2.2 Publications	65
3.2.3 Statement of contribution to publication by authors	73
3.2.4 Conclusion and implications of findings.....	73
CHAPTER 4: NUTRITIONAL RISK IN OLDER ADULTS FOLLOWING DISCHARGE FROM REHABILITATION TO THE COMMUNITY.....	75
4.1 Preliminary exploratory literature review	77
4.1.1 Search strategy	77
4.1.2 Selection strategy and procedures	77
4.1.3 Quality assessment	77
4.1.4 Results	83
4.1.5 Discussion	83
4.2 The consequences of malnutrition following discharge from rehabilitation to the community: A systematic review of current evidence in older adults.....	84
4.2.1 Introduction	84
4.2.2 Publications	84
4.2.3 Further details of search results.....	95
4.2.4 Statement of contribution to publication by authors	95
4.2.5 Conclusion and implications of findings.....	95
PART III: MALNUTRITION IN THE OLDER AUSTRALIAN RURAL REHABILITATION COMMUNITY	97
CHAPTER 5: THE IDENTIFICATION OF MALNUTRITION IN GERIATRIC REHABILITATION	99
5.1 Background.....	101

5.2 Nutrition screening in rural geriatric rehabilitation	102
5.2.1 Introduction	102
5.2.2 Publications	103
5.2.3 Statement of contribution to publication by authors	112
5.2.4 Post-hoc power assessment	112
5.2.5 Conclusion and implication of findings	113
5.3 Malnutrition in rural geriatric rehabilitation: Prevalence, health-related longitudinal outcomes and the validity of nutrition assessment tools	115
5.3.1 Introduction	115
5.3.2 Publications	116
5.3.3 Statement of contribution to publication by authors	128
5.3.4 Long-term mortality outcomes	128
5.3.5 Conclusion and implication of findings	129
5.4 The identification of malnutrition in the rehabilitation setting	133
5.4.1 Introduction	133
5.4.2 Publication	133
5.4.3 Statement of contribution to publication by author	143
5.4.4 Conclusion and implications for practice	143
5.5 Conclusions	144
CHAPTER 6: MALNUTRITION ACROSS THE CONTINUUM OF CARE	147
6.1 The nutritional journey of malnourished older adults, with informal caregivers, from rehabilitation to home	149
6.1.1 Introduction	149
6.1.2 Publications	149
6.1.3 Statement of contribution to publication by authors	159
6.1.4 Conclusion and implication of findings	159
CHAPTER 7: EXAMINATION OF THE ROLES, EXPERIENCES AND NEEDS OF INFORMAL CAREGIVERS OF MALNOURISHED OLDER ADULTS IN THE REHABILITATION COMMUNITY	161
7.1 The perspective of female informal caregivers of malnourished older rehabilitation patients	163
7.1.1 Introduction	163
7.1.1 Review of qualitative methodology	164
7.1.2 Publication	170
7.1.3 Statement of contribution	199
7.1.4 Conclusion	199

PART IV: CONCLUSION	201
CHAPTER 8: CONCLUSIONS AND IMPLICATIONS OF FINDINGS	203
8.1 Conclusions.....	205
8.1.1 Summary of novel contributions	205
8.1.2 Limitations of the current research.....	208
8.2 Implications of findings	212
8.2.1 Implications for practice.....	212
8.2.2 Implications for research	223
8.2.3 Implications for policy	226
8.3 Malnutrition on the rehabilitation agenda.....	228
REFERENCES	231
Appendix I.....	251
Appendix II	254
Appendix III.....	259
Appendix IV	260
Appendix V.....	262
Appendix VI.....	287
Appendix VII	293
Appendix VIII.....	294
Appendix IX.....	295
Appendix X.....	297
Appendix XI.....	298
Appendix XII	303
Appendix XIII.....	306

LIST OF PUBLICATIONS RELEVANT TO THE THESIS

ii. List of manuscripts published in peer-reviewed journals

Marshall S, Bauer J, Capra S, Isenring E. (2013) Are informal carers and community care workers effective in managing malnutrition in the older adult community? A systematic review of current evidence. *Journal of Nutrition, Health & Aging* **17**, 645-651.

- Chapter 3.2.2
- ISSN: 1279-7707, DOI: 10.1007/s12603-013-0341-z
- Impact factor: 2.996
- 2014 ISI Journal Citation Reports Ranking: 21/50 (Geriatrics & Gerontology), 26/77 (Nutrition & Dietetics)
- Citations: 9 (Scopus, Google Scholar)

Marshall S, Bauer J, Isenring E. (2014) The consequences of malnutrition following discharge from rehabilitation to the community: A systematic review of current evidence in older adults. *Journal of Human Nutrition and Dietetics*, **27**: 133-141.

- Chapter 4.2.2
- ISSN: 0952-3871, DOI: 10.1111/jhn.12167
- Impact factor: 2.583
- 2014 ISI Journal Citation Reports Ranking: 49/77 (Nutrition & Dietetics)
- Citations: 19 (Scopus, Google Scholar)

Marshall S, Young A, Bauer J, Isenring E. (2016) Nutrition screening in geriatric rehabilitation: Criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and the Mini Nutritional Assessment-Short Form (MNA-SF). *Journal of the Academy of Nutrition and Dietetics*, **116**:795-801.

- Chapter 5.2.2
- ISSN: 2212-2672, DOI: 10.1016/j.jand.2015.06.012.
- Impact factor: 3.609
- 2014 ISI Journal Citation Reports Ranking: 16/77 (Nutrition & Dietetics)
- Citations: 2 (Scopus, Google Scholar)

Marshall S, Young A, Bauer J, Isenring E. (2016) Malnutrition in geriatric rehabilitation: prevalence, patient outcomes and criterion validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA) *Journal of the Academy of Nutrition and Dietetics*, **116**:785-794.

- Chapter 5.3.2
- ISSN: 2212-2672, DOI: 10.1016/j.jand.2015.06.013
- Impact factor: 3.609
- 2014 ISI Journal Citation Reports Ranking: 16/77 (Nutrition & Dietetics)
- Citations: 1 (Scopus, Google Scholar)

Marshall S. (2016) Protein-energy malnutrition in the rehabilitation setting: evidence to improve identification. *Maturitas*, **86**: 77-85.

- Chapter 5.4.2
- ISSN: 0378-5122, DOI: 10.1016/j.maturitas.2016.01.014
- Impact factor: 3.120
- 2014 ISI Journal Citation Reports Ranking: 22/50 (Geriatrics & Gerontology), 14/79 (Obstetrics & Gynecology)
- Citations: 0 (Scopus, Google Scholar)

Marshall S, Young A, Bauer J, Isenring E. (2015) Malnourished older adults admitted to rehabilitation in rural New South Wales remain malnourished throughout rehabilitation and once discharged back to the community: a prospective cohort study. *Journal of Aging Research and Clinical Practice*, **4**(4): 197-204.

- Chapter 6.1.2
- ISSN: 2273-421X, DOI: 10.14283/jarcp.2015.72
- Impact factor: N/A
- 2014 ISI Journal Citations Reports Ranking: N/A
- Citations: 2 (Scopus, Google Scholar)

Marshall S, Reidlinger D, Young A, Isenring E (2016) The food and nutrition-related roles, experiences and support needs of female informal caregivers of malnourished older rehabilitation patients. *Journal of Human Nutrition & Dietetics*, In press.

- Chapter 7.1.2
- ISSN: 0952-3871, DOI: N/A
- Impact factor: 2.853
- 2014 ISI Journal Citation Reports Ranking: 49/77 (Nutrition & Dietetics)
- Citations: N/A (not yet published or available online)

Agarwal E, **Marshall S**, Miller M, Isenring E (2016) Optimising nutrition in residential aged care: A narrative review. *Maturitas*, In press.

- Chapter 2.7.3
- ISSN: 0378-5122, DOI: 10.1016/j.maturitas.2016.06.013
- Impact factor: 3.120
- 2014 ISI Journal Citation Reports Ranking: 22/50 (Geriatrics & Gerontology), 14/79 (Obstetrics & Gynecology)
- Citations: N/A

iv. List of published conference abstracts

Marshall S, Bauer J, Capra S, Isenring E. Are informal carers and community care workers effective in managing malnutrition in the older adult community? A systematic review of current evidence [Abstract]. *Nutrition & Dietetics*. 2013;70 (S1):15.

- Chapter 3.2.2
- ISSN: 1446-6368
- Impact factor: 0.899
- 2014 ISI Journal Citation Reports Ranking: 69/77 (Nutrition & Dietetics)

Marshall S, Bauer J, Isenring E. The consequences of malnutrition following discharge from rehabilitation to the community: A systematic review of current evidence in older adults [Abstract]. *Nutrition & Dietetics*. 2014;71(S1):5.

- Chapter 4.2.2
- ISSN: 1446-6368
- Impact factor: 0.899
- 2014 ISI Journal Citation Reports Ranking: 69/77 (Nutrition & Dietetics)

Marshall S, Bauer J, Young A, Isenring E. Nutrition assessment in geriatric rehabilitation: comparing the Scored Patient-Generated Subjective Global Assessment (PG-SGA) with the Mini Nutritional Assessment (MNA) [Abstract]. *Nutrition & Dietetics*. 2014;71(S1):52.

- Chapter 5.3.2
- ISSN: 1446-6368
- Impact factor: 0.899
- 2014 ISI Journal Citation Reports Ranking: 69/77 (Nutrition & Dietetics)

Marshall S, Young A, Bauer J, Isenring E. Nutrition screening in geriatric rehabilitation: Criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and the Mini Nutritional Assessment-Short Form (MNA-SF) [Abstract]. *Nutrition & Dietetics*. 2015;72(S1):53.

- Chapter 5.2.2
- ISSN: 1446-6368
- Impact factor: 0.899
- 2014 ISI Journal Citation Reports Ranking: 69/77 (Nutrition & Dietetics)

Marshall S, Young A, Bauer J, Isenring E. Malnutrition in geriatric rehabilitation: prevalence, patient outcomes and criterion validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA) [Abstract]. *Journal of Gastroenterology and Hepatology*. 2015;30(S3):160.

- Chapter 5.3.2
- ISSN: 0815-9319
- Impact factor 3.322
- 2014 ISI Journal Citation Reports Ranking: 26/76 (Gastroenterology & Hepatology)

LIST OF PRESENTATIONS RELEVANT TO THE THESIS

v. List of oral presentations relevant to the thesis

Skye Marshall, Judith Bauer, Sandra Capra, Elizabeth Isenring. Are informal carers and community care workers effective in managing malnutrition in the older adult community? A systematic review of current evidence.

- Presented by Skye Marshall
- Chapter 3.2.2
- 30th Dietitians Association of Australia (DAA) National Conference, Canberra, May 2013.
- Featured in plenary session “Best of the best” and DAA media release (appendix XIII)



Figure i.i: Cartoon depiction of PhD Scholar Ms. Marshall presenting in the *Best of the Best* plenary session at the 30th National Conference of the Dietitians Association of Australia in Canberra, 2013. Artwork by Andrew Hore.

Skye Marshall, Judith Bauer, Elizabeth Isenring. The consequences of malnutrition following discharge from rehabilitation to the community: A systematic review of current evidence in older adults.

- Presented by Skye Marshall
- Chapter 4.2.2
- 31st DAA National Conference, Brisbane, May 2014

Skye Marshall, Adrienne Young, Judith Bauer, Elizabeth Isenring. Criterion validity of nutrition screening and assessment tools in geriatric rehabilitation.

- Presented by Skye Marshall
- Chapter 5.2.2
- DAA Qld Branch Professional Development event “3 Minutes to Shine” session, Brisbane, July 2015.

Skye Marshall, Adrienne Young, Judith Bauer, Elizabeth Isenring. Malnutrition in geriatric rehabilitation: prevalence, patient outcomes and criterion validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA).

- Presented by Skye Marshall
- Chapter 5.3.2
- Bond University Faculty of Health Sciences and Medicine Higher Degree Research Conference, Robina, November 2015.
- Winner of Best Oral Presentation (appendix XIII)

Skye Marshall, Adrienne Young, Judith Bauer, Elizabeth Isenring. Malnourished older adults with informal caregivers admitted to rural rehabilitation units remain malnourished during and after rehabilitation: a prospective cohort study of current practice

- Presented by Skye Marshall
- Chapter 5.4.2
- International Association of Geriatrics and Gerontology Asia & Oceania 2015 Conference, Chiang Mai, Thailand, October 2015.

Skye Marshall, Adrienne Young, Judith Bauer, Elizabeth Isenring. Malnourished older adults with informal caregivers admitted to rural rehabilitation units remain malnourished during and after rehabilitation: a prospective cohort study of current practice

- Presented by Skye Marshall
- Chapter 5.4.2
- Australian Association of Gerontology 48th National Conference, Alice Springs, November 2015.

Skye Marshall. Superheros of the nutrition team.

- Presented by Skye Marshall
- Bond University Three Minute Thesis Competition.
- Second place / runner up (appendix XIII)

vi. List of poster presentations relevant to the thesis

Skye Marshall, Judith Bauer, Adrienne Young, Elizabeth Isenring. Nutrition assessment in geriatric rehabilitation: comparing the Scored Patient-Generated Subjective Global Assessment (PG-SGA) with the Mini Nutritional Assessment (MNA).

- Presented at the Dietitian Association of Australia's National Conference in Brisbane, May 2014.

Skye Marshall, Adrienne Young, Judith Bauer, Elizabeth Isenring. Nutrition screening in geriatric rehabilitation: Criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and the Mini Nutritional Assessment-Short Form (MNA-SF).

- Displayed at the Dietitian Association of Australia's National Conference in Perth, May 2015.

Skye Marshall, Judith Bauer, Adrienne Young, Elizabeth Isenring. Malnutrition in geriatric rehabilitation: prevalence, patient outcomes and criterion validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA).

- Presented at AuSPEN / GASTRO2015 Conference in Brisbane, September 2015.

Skye Marshall, Judith Bauer, Adrienne Young, Elizabeth Isenring. Malnutrition in geriatric rehabilitation: prevalence, patient outcomes and criterion validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA).

- Presented at Bond University Faculty of Health Sciences and Medicine Higher Degree Research Conference, Robina, November 2015.

Skye Marshall, Adrienne Young, Judith Bauer, Elizabeth Isenring. Nutrition screening in geriatric rehabilitation: Criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and the Mini Nutritional Assessment-Short Form (MNA-SF).

- Presented at Bond University Faculty of Health Sciences and Medicine Higher Degree Research Conference, Robina, November 2015.

Skye Marshall, Adrienne Young, Judith Bauer, Elizabeth Isenring. Malnourished older adults with informal caregivers admitted to rural rehabilitation units remain malnourished during and after rehabilitation: a prospective cohort study of current practice

- Presented at Bond University Faculty of Health Sciences and Medicine Higher Degree Research Conference, Robina, November 2015

LIST OF FIGURES AND TABLES

vii. List of figures

Figure i.i: Cartoon depiction of PhD Scholar Ms. Marshall presenting in the *Best of the Best* plenary session at the 30th National Conference of the DAA in Canberra, 2013. Artwork by Andrew Hore.

Chapter 1

Figure 1.1: Global population pyramid in 2002 and 2025 indicating the triangular pyramid of 2002 will be replaced with a more cylinder-like shape in 2025.

Figure 1.2: Modes of care in the aged care system.

Figure 1.3: Population aged 65 years and over on the 30 June 2010, statistical divisions, Australia.

Figure 1.4: Population aged 65 years and over on the 30 June 2013, statistical divisions, Australia.

Figure 1.5: Proposed theoretical framework addressing the effects of informal caregivers on the health-related outcomes of older adult care-recipients in home health care.

Figure 1.6: Theoretical framework of those who have an influence on the nutritional risk of rural community-dwelling older adults.

Chapter 2

Figure 2.1: Etiology-Based Malnutrition Definitions recommended by the Academy of Nutrition and Dietetics (AND) for the identification and documentation of adult malnutrition.

viii. List of tablesChapter 2

Table 2.1: Sarcopenia diagnostic criteria according to the European Working Group on Sarcopenia, the International Working Group on Sarcopenia and the Society for Sarcopenia, Cachexia and Wasting Disorders.

Table 2.2: Physiological effects and consequences of malnutrition.

Table 2.3: The International Statistical Classification of Diseases and Health Related Problems 10th Revision, Australian Modification (ICD-10-AM) classifications for protein-energy malnutrition for adults.

Table 2.4: Categories of the Body Mass Index (BMI) for adult individuals according to the World Health Organisation.

Table 2.5: Prevalence of malnutrition in the rehabilitation setting according to the Mini Nutritional Assessment (MNA), Subjective Global Assessment (SGA) or ICD-10-AM classification of protein-energy malnutrition.

Table 2.6: Prevalence of malnutrition in the rehabilitation setting according to the Mini Nutritional Assessment (MNA), Subjective Global Assessment (SGA) or Scored Patient-Generated Subjective Global Assessment (PG-SGA).

Chapter 3

Table 3.1: Evidence summary of health education provided to informal caregivers and non-clinical care workers of community-dwelling older adults.

Chapter 4

Table 4.1: Evidence summary of malnutrition-related health indicators in rehabilitation and transitional care in-patients pre and/or post discharge.

Table 4.2: Outcome measures of rehabilitation and transitional care in-patient and post-discharge studies.

Table 4.3: Number of citations generated and full-texts extracted from the search of seven databases for the consequences of malnutrition following discharge from rehabilitation to the community.

Chapter 7

Table 7.1: Summary of the characteristics of prominent qualitative methodologies used in health care research.

LIST OF ABBREVIATIONS

Abbreviations included in this thesis are listed below. Abbreviations were used in this thesis only where the phrase is used more than twice or the phrase is commonly known by its abbreviation as opposed to its full spelling. Abbreviations included exclusively in tables within the thesis are excluded from this list, as they are included as footnotes below each table. Abbreviations included exclusively within publications are excluded from this list as they are described in full within each publication.

ABS, Australian Bureau of Statistics

AND, Academy of Nutrition & Dietetics

AUD, Australian dollar

BMI, body mass index

CACP, Community Aged Care Packages

CDC, consumer-directed care

CHSP, Commonwealth Home Support Programme

DAA, Dietitians Association of Australia

EACH, Extended Aged Care at Home

EACH-D, Extended Aged Care at Home Dementia

FTE, full-time equivalent

HACC, Home and Community Care

HRQoL, health-related quality of life

HPHE, high protein-high energy

ICD-10-AM, International Statistical Classification of Diseases and Health Related Problems 10th Revision, Australian Modification

ICDA, International Confederation of Dietetic Associations

IPA, Interpretative phenomenological analysis

MARRC, Malnutrition in the Australian Rural Rehabilitation Community

MNA, Mini Nutritional Assessment

MNA-SF, Mini Nutritional Assessment – Short Form

MSS, Malnutrition Sarcopenia Syndrome

MST, Malnutrition Screening Tool

MUST, Malnutrition Universal Screening Tool

NHMRC, National Health and Medical Research Council

NRCP, National Respite for Carers

NSQHS, National Safety and Quality Health Service

NSW, New South Wales

ONS, oral nutritional supplements

PEN, Practice-based Evidence in Nutrition

PG-SGA, Patient-Generated Subjective Global Assessment

RAC, residential aged care

RACF, residential aged care facilities

RCT, randomised controlled trial

SCREEN II, Seniors in the Community: Risk Evaluation for Eating and Nutrition

SGA, Subjective Global Assessment

SNAQ, Simplified Nutritional Assessment Questionnaire

STROBE, STrengthening the Reporting of OBservational studies in Epidemiology

TIDieR, Template for Intervention Description and Replication

USA, United States of America

WHO, World Health Organisation

UK, United Kingdom

USD, United States of America dollar

OUTLINE OF THESIS

ix. Part 1: Introduction

Part 1 presents background literature which forms the foundation upon which this thesis is based.

Chapter 1 examines ageing in the Australian context, and the unique challenges our changing population demographic brings. This chapter highlights that there is an increased need for services to promote independent ageing, and that addressing chronic conditions such as malnutrition is critical. The time to meet these challenges is now; however, the nutrition-related evidence-base for how to do so is still lacking. Engaging and supporting non-clinical community care workers and informal caregivers of older adults presents a significant, cost-effective strategy to support the health and aged care systems. This chapter provides justification for the thesis, which aims to increase the evidence-base for improving the nutrition status of older adults in rural Australia across the continuum of care and exploring the role of caregivers in supporting nutrition-related care during these transitions.

Chapter 2 examines protein-energy malnutrition, a significant contributor to the burden of the ageing population on the health and aged care systems. Malnutrition is examined across the continuum of care, and opportunities are identified for further research which are likely to help meet the challenges of Australia's ageing population, informing the research studies undertaken as part of this thesis. This chapter identifies significant opportunities to increase the independence of older adults through preventing and treating malnutrition in rehabilitation and community settings, which may prevent or delay institutionalisation, hospitalisation and mortality.

x. Part 2: Systematic Literature Reviews

In order to build upon the examinations undertaken in part 1, two systematic literature reviews (Chapters 3 and 4) were undertaken to provide high-level evidence for opportunities to support malnourished older adults in rehabilitation and the community.

Chapter 3 presents a systematic review of the efficacy of engaging non-clinical community care workers or informal caregivers as part of the nutrition care team for malnourished older adults. This systematic review was undertaken in the community setting, as this is the predominant setting that these two types of caregivers support their care-recipients. This review found that there is not yet any evidence for engaging the non-clinical community care workers in treating malnourished older adults; however, there is good

evidence to show that informal caregivers who are trained by health care workers to provide treatment for malnutrition are in fact effective in improving the nutrition status, quality of life and physical function of their care-recipients.

Chapter 4 presents a second systematic review focussed on malnourished older adults in their transition from rehabilitation to the community. This review aimed to describe changes in nutritional status of the older adults, as well as identify efficacious nutrition-related interventions for older adults once they are discharged home. However, results showed that no intervention studies addressing malnutrition in rehabilitation have evaluated outcomes once the participant has been discharged from rehabilitation. Although observational studies showed that malnourished older adults are more likely to be hospitalised, institutionalised, have a poorer physical function and quality of life and are more likely to die post-rehabilitation. No study has ever measured whether malnutrition persists once rehabilitation patients return back to their own homes.

xi. Part 3: Malnutrition in the Older Australian Rural Rehabilitation Community

The two systematic reviews in Part 2 informed the design of an observational prospective cohort study (Chapters 5 and 6) and a qualitative study (Chapter 7) to increase our understanding of the nutritional journey that older adults with informal caregivers make from rehabilitation to the community, and the best method to screen and assess malnutrition in geriatric rehabilitation.

Chapter 5 describes a study which evaluates the criterion (concurrent and predictive) validity of two nutrition screening tools for geriatric rehabilitation to aide clinicians in selecting a validated screening tool for use in their rehabilitation unit. Chapter 5 also reports the malnutrition prevalence and health care use of malnourished older adults in rural rehabilitation units in Australia, outcomes which have never previously been described. Furthermore, this chapter evaluates the criterion validity of two nutrition assessment tools for geriatric rehabilitation to aide clinicians in selecting a validated assessment tool, minimising the chance of misdiagnosis in this setting. Finally, chapter 5 includes a narrative review which was undertaken in 2015, which aims to provide an update on identifying malnutrition in the rehabilitation setting. This chapter addresses common problems which cause malnutrition to continue to be under-recognised and under-diagnosed. This includes an examination of “geriatric syndromes” which present with involuntary loss of lean tissues (including malnutrition), a review of malnutrition prevalence with consideration given to region and method of diagnosis, and then a

comparative examination of nutrition screening and assessment tools for use in rehabilitation.

Chapter 6 describes the first study to measure the change in nutrition status of malnourished older adults once they are discharged home from rehabilitation. This study found that if an older adult is admitted to rehabilitation with malnutrition, whether moderate or severe, they are likely to be discharged with moderate malnutrition and remain moderately malnourished for at least 12 weeks in their homes. This study also found that their physical function tended to decrease and their health-related quality of life (HRQoL) remained low. This is likely to be a best case scenario as these older adults had an informal caregiver to support their transition home.

Chapter 7 provides the final study undertaken as part of this thesis. This is a qualitative study which involved interviewing informal caregivers of malnourished older adults admitted to rehabilitation, once during rehabilitation and once again two weeks after discharge of their care-recipient from rehabilitation. This study aimed to examine the caregivers' experience, roles and support needs so that malnutrition-related interventions for older adults in rehabilitation can be both patient-based and informal caregiver-based. This study identified three main drivers of the perspectives of the informal caregivers: *responsibility*, *caregiver nutrition ethos*, and *quality of life*. Examination of these drivers were used to create suggestions for practice and recommendations for further research.

xii. Part 4: Conclusion

The current thesis has made a significant contribution towards its aim; specifically in the transition of older adults from rehabilitation to the community in rural Australia. The thesis has exposed areas for further research to strengthen preliminary findings outlined in chapters 1 - 7 and to gain a more comprehensive understanding of how to best provide evidence-based nutrition care for these patients.

This thesis comprises narrative reviews, systematic reviews, a prospective observational cohort study and finally a qualitative study. Chapter 8 discusses in detail how these reviews and studies have contributed novel and significant findings towards the evidence-base for malnutrition across the continuum of care. Limitations are discussed, as well as the implications for practice, research and policy. Finally, overall conclusions are drawn and a call to action is made regarding malnutrition on the rehabilitation agenda.



PART I

INTRODUCTION

CHAPTER 1

THE AUSTRALIAN AGEING POPULATION AND ASSOCIATED DEMANDS ON CARE DELIVERY

1.1 An ageing Australia

Population ageing is a decline in the proportion of youth and an increase in the proportion of older persons (Figure 1.1) (2002). Although ‘older persons’ has no agreed definition, from 1970 to 2025 the worldwide population growth of persons ≥ 60 years is expected to increase by 223%, or 694 million, making it the fastest growing age group (2002). By 2050 this will increase to two billion. In 1999 the Director-General of the World Health Organisation (WHO), said “*Population ageing is first and foremost a success story for public health policies as well as social and economic development...*” (2002).

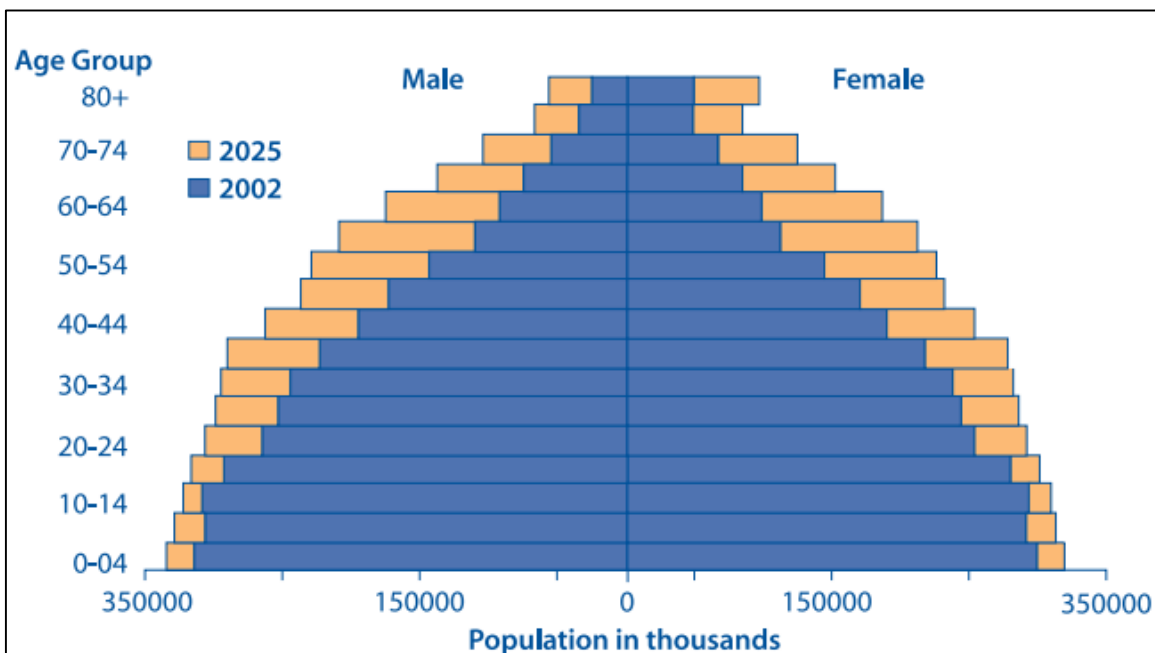


Figure 1.1: Global population pyramid in 2002 and 2025 indicating the triangular pyramid of 2002 will be replaced with a more cylinder-like shape in 2025 (2002).

Due to sustained low fertility and increasing life expectancy, Australia has had an ageing population for most of the twentieth century, with the exception of the post-World War II baby boom. In 2015, Australia has the highest male life expectancy in the world, and the fifth highest female life expectancy (2015a). These changes in the Australian population demographic have resulted in an ageing population similar to that of the United Kingdom (UK), Canada and the United States of America (USA) (2007b). In 2013, 14% of the Australian population were aged 65 years or over; this is projected to increase to 16% by 2015, with the median age increasing by three years (36.9 years to 39.9 years) in that short timeframe (2014a; ABS, 2010). By 2036, the number of Australians aged 65 years and over will more than double, reaching 6.3 million and will represent 24% of the total population (2007b). Furthermore, Australians aged 85 years and over, who have the highest

need for health services, are the fastest growing age group with a projected increase from 330 000 in 2006 to 1.1 million in 2036 (2007b).

1.1.1 Defining older adults

The United Nations defines older people as those aged 60 years or more, as does the Australian Bureau of Statistics (ABS) (2002; 2004). However, there is no agreed definition of ‘older Australians’ and 60 years may be considered relatively young as Australian workers do not qualify for the Age Pension until they reach 65 years (2009). When planning for aged care services, the Australian government uses 70 years as the minimum age (2011b), however, patients are eligible for the Medicare health assessment only when they reach 75 years. Although the ageing process is continuous, setting arbitrary age categories is useful for planning and service provision, as well as research. The classifications suggested by Suzman and Riley (Suzman & Riley, 1985) have been widely accepted and used in the literature; these include:

- Young-old: 65 – 74 years.
- Middle-old: 75 – 84 years.
- Oldest-old: ≥ 85 years.

However, due to accelerated dysfunction found in those aged 95 – 100 years, Fries and associates (Fries et al., 2000) recommend a fourth category: very oldest-old (≥ 95 years). The terms “older adult”, “older Australians” or “geriatric” used throughout this thesis refers to persons aged 65 years or older. Whilst we use these categories to represent the stages of change during ageing, it must be acknowledged that there are substantial variations in the health and functional status of individuals of the same age. This must be considered when designing policy and research to avoid discrimination based on chronological age (2002).

1.2 Aged care delivery in Australia

Whilst population ageing is considered a triumph for humanity, it also presents some of the greatest challenges to economic and social systems around the world (2002). The question has been posed: “*are increases in life expectancy accompanied by a concurrent postponement of functional limitations and disability?*” (Christensen et al., 2009). Although the answer still remains open, the WHO argues that if governments implement “active ageing” policies and programmes, which enhance the health and independence of older adults, that countries will be well equipped to meet the challenges of the ageing population; however the time to plan and enact these is now (2002). In 2011, the Australian Government Productivity Commission conducted an inquiry into aged care in Australia

(2011b). The Productivity Commission defined the challenges the ageing population presents to the Australian aged and health systems; these include:

- A significant increase in demand.
- Significant shifts in the type of care demanded, with:
 - An increased preference to independent living arrangements and choice in aged care services.
 - Greater levels of affluence among older people, recognising income and asset levels vary widely.
 - Changing patterns of disease among the aged, including increasing incidence of chronic disease such as dementia, severe arthritis and serious visual and hearing impairments, and the costs associated with care.
 - Reduced access to carers and family support due to changes in social and economic circumstances.
 - The diverse geographic spread of the Australian population.
 - An increasing need for psycho geriatric care and for skilled palliative care.
- The need to secure significant expansion in the aged care workforce at a time of 'age induced' tightening of the labour market and wage differentials with other comparable sectors.

Furthermore, the report (2011b) recommended that future policy regarding the aged care system should aim to:

- Promote the independence and wellness of older Australians and their continuing contribution to society.
- Ensure that all older Australians needing care and support have access to person-centred services that can change as their needs change.
- Be consumer-directed, allowing older Australians to have choice and control over their lives and to die well.
- Treat older Australians receiving care and support with dignity and respect.
- Be easy to navigate, with older Australians knowing what care and support is available and how to access those services.
- Assist informal caregivers to perform their caring role.
- Be affordable for those requiring care and for society more generally.
- Provide incentives to ensure the efficient use of resources devoted to caring for older Australians and broadly equitable contributions between generations.

The Productivity Commission concluded that Australia's aged care system is not currently well placed to meet these future challenges, and in particular that the system is difficult to navigate, provides limited services and consumer choice, does not provide sufficient home care, services are variable in quality, there is a workforce shortage exacerbated by some workers being insufficiently skilled and is marred by inequities in availability of services and pricing structures (2011b; 2012a). In response, the Australian government developed the "Living Longer, Living Better, Aged Care Reform Package", released in April 2012 (2012c).

1.2.1 Australian aged care programs and services

The Home and Community Care Act 1985 provides a framework from which the Australian Government, States and Territories provide services to support older Australians, or younger Australians with a disability, and their caregivers (also referred to as carers) to live independently in their home and prevent premature institutionalisation. Figure 1.2 represents the programs and components of this community care services framework. They range from basic home support, such as domestic assistance, to intensive care services delivered at home or in residential institutions.

These services may be further summarised into levels of care (2012a):

1. Low intensity interventions: information, assessment and referral services, support for caregivers, Home and Community Care (HACC), National Respite for Carers (NRCP), Veteran's Home Care, Department of Veterans' Affairs, community nursing, day therapy centres and respite residential care.
2. Low-level care: Community Aged Care Packages (CACP), some packaged through HACC, carer payment and carer allowance and low-level permanent residential care.
3. High-level care: Extended Aged Care at Home (EACH) and EACH Dementia (EACH-D), some packaged through HACC, transitional care and high-level permanent residential care.

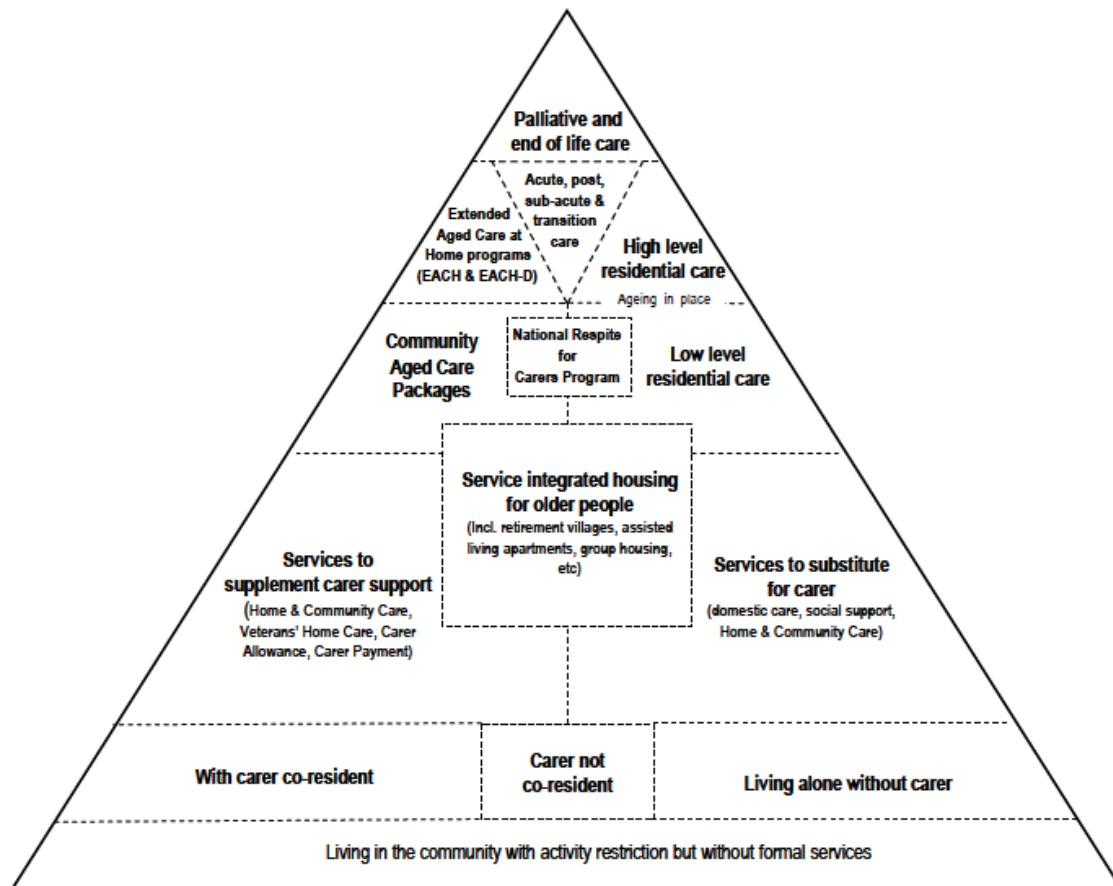


Figure 1.2: Modes of care in the aged care system (2011f)

In recognition that older Australians desire to remain in their own homes for as long as possible, the Department of Health and Ageing, as part of the Aged Care Reform Package, will invest \$955.4 million over five years (until June 2017) to provide better in-home care (2012c). In 2015, a new streamlined ‘Commonwealth Home Support Programme’ (CHSP) will be introduced consolidate the existing NRCP, day therapy centres and assistance with care and housing for the aged with HACC. In addition, more than 26 400 home care packages will be released by 2016 and this will increase to 64 200 by the year 2022 (2012c).

1.2.2 Changes to Australian aged care programs and services since 2013

Consumer Directed Care (CDC) began in August 2013, and in July 2014 a new system of fees, income testing and home care reviews were implemented by the Australian Aged Care Quality Agency, a statutory agency established in January 2014 (2015f). Early criticism of CDC includes that it increases anxiety for the elderly due to the increased responsibility of making care provision decisions (Moran et al., 2013). However, the majority of research regarding CDC indicates that the approach increases patient satisfaction, but does not improve outcomes related to patient wellbeing (Low et al., 2011). As a result, aged care

programs have improved upon CDC by including an approach to enhance reablement, which has been shown to improve physical function and quality of life (Lewin et al., 2013a; Lewin et al., 2013b).

However, the CDC and reablement programs have received further criticism in that they are founded upon research conducted entirely in the RAC and hospital setting, and therefore may not reflect the needs of the home care setting for which they were designed (Mukamel et al., 2014). Indeed, the Australian Association of Gerontology, in their “Response to the Productivity Commission Inquiry: Caring for Older Australians”, argued that changes to the aged care system will require broad cross-disciplinary and collaborative research and therefore requires a dedicated funding stream facilitated by the Australian Research Council and the National Health and Medical Research Council (NHMRC). Further criticism of the reforms as of January 2015 include reports by aged care agencies which indicate less than one in 16-17 applications are approved and the wait list for approved applicants is inappropriately long, often leading to the patient being admitted to a residential aged care facility (RACF) or dying before services commence (Low, 2015).

The CHSP commenced 1 July 2015. The program supports 550,000 older adults and their caregivers each year so that they may remain independently living in their own homes. The programme receives AUD\$1.7billion in 2015-16 and funding is projected to increase as the demand for packages increases (2015b). Features of the programme include streamlined access to services, a standardised national assessment process accessed through <http://www.myagedcare.gov.au/>, an increased focus on “reablement” with a restorative approach to wellness, a consistent fees policy and decreased bureaucratic processes for obtaining funding (2015c).

1.2.3 Geographical challenges of service delivery in Australia

The proportion of Australians aged ≥ 65 years increased in all states and territories from the 2005 to 2010 census, with Tasmania and South Australia having the highest proportion (15.6%) and the Northern Territory the lowest (5.5%) (2011a). By the 2013 census, Tasmania and South Australia continued to have the highest proportions of people aged over 65 years, both now at 17% (2014a). New South Wales (NSW) however had the largest increases in the proportion of older Australians (N=110,300). Figure 1.3 shows the ≥ 65 year population density across Australian statistical regions in 2010, and figure 1.4 shows how these regions have changed in 2013, showing a shift for older adults to be concentrated in rural and regional NSW, Tasmania and Victoria.

Populations in rural areas are ageing more rapidly than populations in major urban or regional centres, and the size of the older (≥ 75 years) rural population grew 3% per year from 1998 to 2008 (2011b). In 2001, the population of Australians ≥ 65 years residing in larger rural areas (13.9%) was higher than that of major urban areas (12.5%), but the rural balance (area of state/territory not considered urban or bounded locality) was lower at 9.5% (2003). Whilst a significant proportion of older adults live in regional, rural and remote Australia, these areas typically are not able to sustain many types of aged care services available in urban localities (2011c; 2012c). Challenges in providing aged care in rural and remote areas include:

- The relative high cost of establishing and delivering services.
- Difficulties in attracting, retaining and professionally developing suitably qualified staff.
- The limited availability of medical practitioners and allied health professionals to support the provision of aged care services.

In addition, older adults in rural and remote areas are likely to have a greater need for these services due to poorer health, increased proportion of single older men and less availability of informal care (2011b).

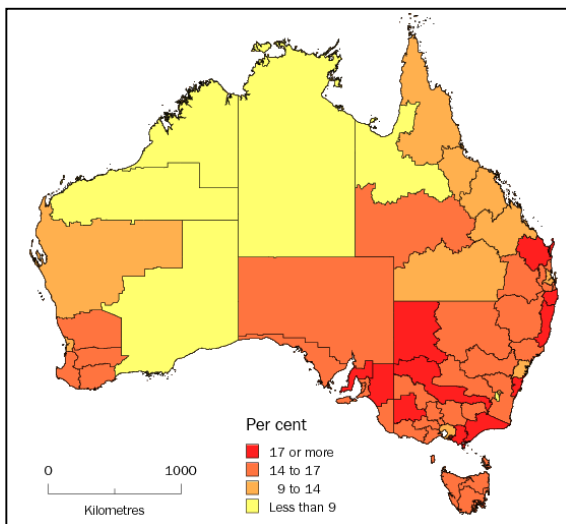


Figure 1.3: Population aged 65 years and over on the 30 June 2010, statistical divisions, Australia (2011a)

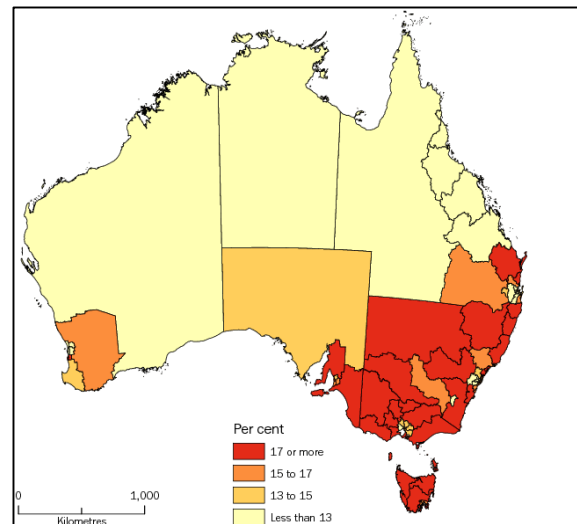


Figure 1.4: Population aged 65 years and over on the 30 June 2013, statistical divisions, Australia (2014a)

1.2.4 Aged care workforce

The aged care sector employs 2.7% of the Australian workforce, 15% of which are registered nurses, 22% enrolled nurses and 64% non-clinical personnel and community care workers (2012c). The aged care workforce is pressured by a limited supply of adequately trained and qualified workers across Australia, but particularly in rural and regional areas (2011c; 2012c). Furthermore, the ageing population will lead to an increase in the health care sector which will compete with the aged sector for workers. These pressures on resourcing aged care staff in rural and remote areas are exacerbated by the increased costs to employers; this is due to higher remuneration of temporary workers, increased travel, professional development and back-fill costs and limited affordable accommodation (2011c).

In response to these workforce pressures, the sector has been moving towards a more streamlined, lower cost workforce by utilising non-clinical care workers. This allows for the more effective use of nursing and health professionals expertise, however it is unclear to what extent this may continue without compromising the care of the individual (2012c). While many older Australians receive this support through HACC, CACPS and other programs, it must be highlighted that the majority of their care and assistance is received from informal caregivers such as a spouse or family member.

1.2.5 Role of the non-clinical aged care worker

The Australian Institute of Health and Welfare have reported on the use of the aged care programs in Australia. Interestingly, nursing services are utilised by only 22% of those who access care through HACC (185.3 / 855.9 persons per 1000 persons in total), with the remainder of services being provided by non-clinical care workers. However, it is important to note that these figures do not represent need and are heavily influenced by supply and availability of service providers (2011b).

Non-clinical care workers are the large majority of the workforce in providing services within these aged care packages. These care workers may have no professional training or may hold trade certificates in aged care, however have no clinical, health or medical training or education. Through HACC and community packaged care (CACPS, EACH, EACH-D)¹, non-clinical care workers assist their care-recipients through care planning and assessment, domestic care, personal care and respite care for informal caregivers. However, in practice health and services assessment and planning are, in most cases, conducted by

¹ Through the CHSP as of 1 July 2015

care managers with a health background. It is the role of the care worker to implement these care plans and monitor the client. As directed by care and service plans, non-clinical care workers are responsible for the nutritional management of their care-recipients by monitoring nutritional and hydration status and functional ability and may assist with preparing meals, eating or actual feeding where necessary (2011d; 2011e). Home care providers are well placed to provide screening and intervention affecting clients' nutritional status, quality of life and functional abilities as they are able to make observations that would otherwise be missed in conventional inpatient or outpatient health care. In entering the clients' home, they are provided with background information relating to the client's environment, values, traditions and beliefs as well as their unidentified needs. This background means that interventions may be more suitable for each client, and ongoing monitoring and feedback allows for development of highly individualised care within the larger aged care system.

Although allied health professionals, including dietitians, and medical officers may also provide home visits, the nature of their clinical specialisation and associated cost means that the home visits are usually less frequent, such as once every month as opposed to care workers who may provide home visits multiple times per week.

1.3 Caring for ageing Australians

1.3.1 Informal care for older adults

The support and caring activities of friends and family members has been termed “informal caregiving or caring²” throughout the literature, to signify the difference from paid or professional caregivers which have no personal relationship with the care-recipient. The ratio of informal caregivers to older adults requiring care has been reduced in recent years and this trend is likely to continue (2010a; 2011b). Projections show the decline in the availability of adults for the potential support of older adults in Australia from 1950 – 2013 is likely to continue until 2100. The probabilistic population projections are based on the ‘World Population Prospects: The 2012 Revision considering total fertility and life expectancy projections’ carried out with a Bayesian Hierarchical Model (2014b).

Adult children, in particular daughters in their 50s and 60s, are the most common type of informal caregiver to older adult parents; however, informal caregivers may also be

² Criticism of the term “informal” includes that it minimises the significant contributions made by family, friend or volunteer caregivers. Although this criticism is valid and recognised, there is not yet an accepted alternative, and therefore the term is used throughout this thesis.

spouses, other family members or friends and neighbours (Van Houtven et al., 2013). Older adults may receive various forms of care from more than one informal caregiver, a social system which may be considered a ‘care network’ and which may more adequately describe the informal sector (Keating et al., 2003). However, the availability of informal care is expected to decline relative to the ageing population, due to the increasing age of first time mothers and the increasing number of single person households (2011b). The proportion of Australians involved in caring for an older adult or person with disability declined from 13% in 2003 to 12% in 2009 (2010a). This trend will have implications for community care demand and health service discharge support services, especially in regards to the increased costs required to provide services. It is estimated that if all hours of informal care were replaced by in-home aged care services, it would make up 3.2% of GDP (2012c), and in 2015 the total replacement cost of informal care in Australia is estimated to be AUD\$60.3billion (2015d).

In order to offset this increasing economic burden, research and policies should be targeted at maximising and supporting informal caregivers (2012c), who assume significant personal and financial costs in their care provision. Though some research has found these burdens to be associated with poor health and psychosocial outcomes in caregivers, this is confounded by the degree of unmet need for community-based care services (Bass et al., 2012; Robison et al., 2009).

1.3.2 The role of rehabilitation in supporting the ageing community

The rehabilitation setting is defined as an in-patient service by a multidisciplinary team with the goal of reducing disability by improving task-orientated functional behaviour (Handoll et al., 2009), such as a stroke or hip fracture rehabilitation centre or rehabilitation ward in a general hospital. Rehabilitation facilities play a vital role in supporting a healthy ageing Australia and are likely to increase in importance as the proportion of older adults increases. It is the role of rehabilitation facilities to increase the independence of older adults with acute and chronic disability so that they may return safely to the community, and prevent premature institutionalisation or hospital readmission. In this way, rehabilitation facilities should be considered an integral support service to the aged care system.

1.4 Nutritional concerns in older adults

While the problems with obesity are well recognised, the health problems associated with malnutrition are not as well acknowledged, despite arguably being more common and more costly (Watterson et al., 2009). Protein-energy malnutrition, herein referred to as “malnutrition”, occurs when food and nutrient intake is unable to meet protein, energy and nutrient requirements over time leading to a disruption of homeostasis in lean tissues, body weight and physical function (Pleuss, 2005; Skipper, 2012). The chronic diseases and the physiological and psychosocial changes that occur in ageing place older adults (≥ 65 y (2010b)) at high nutritional risk (Watterson et al., 2009).

Although malnutrition was first identified as a problem in acute care settings (Krumdieck, 1998), where prevalence is 20-50%, it is also highly prevalent in rehabilitation (30-50%), RAC (40-70%) and community settings (10-30%) (Watterson et al., 2009). Of additional concern, there is NHMRC level I evidence³ (appendix I) to indicate that malnutrition is under-recognised and under-diagnosed in rehabilitation, RACF and in the community with no clear recommendations for prevention and treatment interventions in these settings (Watterson et al., 2009). The role of informal caregivers and non-clinical community care workers in supporting malnourished older adults, across the rehabilitation, RACF and community settings is of high interest due to their potential influence upon the dietary intake of older adults. Malnutrition is further examined in chapter 2.

1.4.1 Informal caregivers’ influence on the nutrition status of older adults

Given the substantial amount of informal care provided to older adults, the influence that informal caregivers have on the health outcomes of the older adult care-recipient must be considered in addition to the care provided by health and aged care services. Cho and associates (Cho, 2007) have developed a theoretical framework (figure 1.5) to provide understanding in how health-related outcomes in older adults may be affected by informal caregivers, who may provide care that varies widely in terms of quality and quantity. The influence of the informal caregiver is affected by the type of relationship of the caregiver-care-recipient dyad, as well as their history and availability. It is also largely influenced by the health and psychosocial background of the care-recipient and the support the informal

³ Strength of the evidence was evaluated according to the National Health and Medical Research Council (NHMRC) levels of evidence according to type of research question. The NHMRC levels of evidence provide a guide to the strength of evidence addressing clinical questions based on a hierarchy of study design, and are graded I (strongest) to IV (weakest). A copy of the NHMRC levels of evidence can be found in appendix I.

caregiver receives, including education or aged care services. All these together will impact on the mental and physical health of the care-recipient, and therefore health care utilisation.

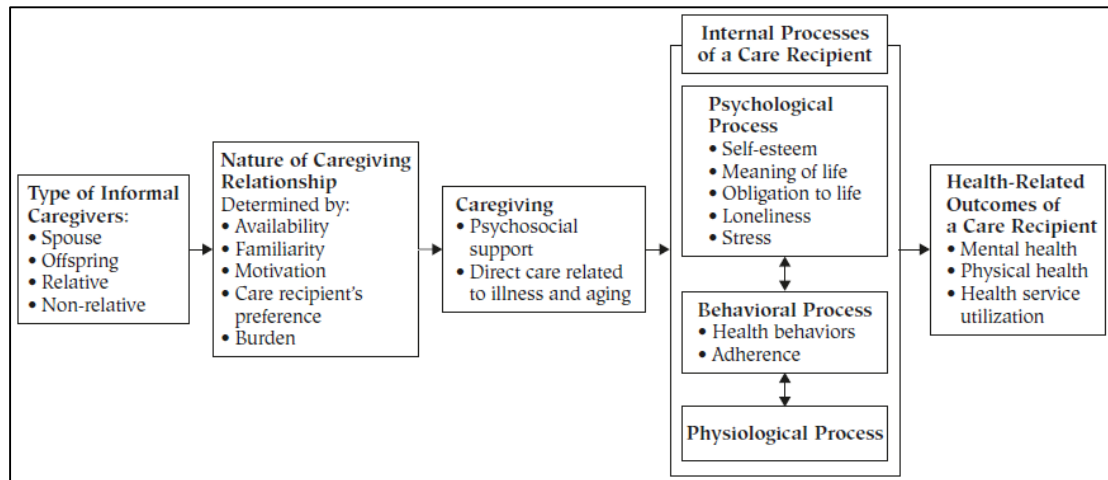


Figure 1.5: Proposed theoretical framework addressing the effects of informal caregivers on the health-related outcomes of older adult care-recipients in home health care (Cho, 2007). This work (DOI: 10.1016/S1976-1317(08)60006-7) has not been modified or built upon and has been shared under a Creative Commons Attribution-NonCommercial-No Derivatives License (CC BY NC ND). The license may be accessed at creativecommons.org/licenses/by-nc-nd/4.0/.

A large part of the caring duties of informal caregivers is related to activities of daily living such as food provision and/or assistance with eating. This will in turn impact upon the nutrition-related health outcomes in older adults. In a sample of 230 homebound older adults, participants were more likely to be undereating if they received either infrequent informal care or very frequent informal care, though the causal relationship has not been explored (Locher et al., 2008). A report by Carers UK states that 60% of 2000 informal caregivers surveyed worried about the nutrition of their care-recipient (2012d). Some researchers have found that the nutrition knowledge of informal caregivers is poor or inaccurate, although caregivers believe their care-recipient received proper nutrition (Ryan, 1997). Even though their nutritional knowledge may be poor, Albert (Albert, 1993) found that informal caregivers of undernourished older adults were able to recognise the gross signs of malnutrition and increased their nutritional care in response, such as the provision of protein supplements and increasing food accessibility. Nevertheless, it is recommended to provide informal caregivers with support in the nutritional management of their care-recipients, such as the provision of nutritional education, which may decrease caregiver

burden and improve nutrition-related health outcomes in older adults (Albert, 1993; Riviere et al., 2001; Ryan, 1997; Salva et al., 2011; Silver & Wellman, 2002b).

1.5 Summary and proposed framework

Australia can be proud of its ageing population as it demonstrates the success of its social, economic and health systems. However, the aged care system is not currently equipped to meet the challenges associated with an increasing number of older adults, particularly in rural and remote areas. Additionally, the health care system must adapt to the changing disease risks associated with an ageing population, such as increased risk of malnutrition. Engaging and supporting the roles of non-clinical care workers and informal caregivers in the community and rehabilitation settings may help the aged and health care systems to meet these challenges, for example by decreasing the need for RACF.

Based on the information presented in this chapter, a theoretical framework was designed (figure 1.6) to represent those who have an influence on the nutrition status of rural community-dwelling older adults. This framework provides a basis from which the literature will be examined and gaps in the evidence for the support of malnourished older adults identified. Therefore, the overall aim of this thesis was to increase the evidence-base for improving the nutrition status of older adults in rural Australia across the continuum of care and exploring the role of caregivers in supporting nutrition-related care during the transition from rehabilitation to home.

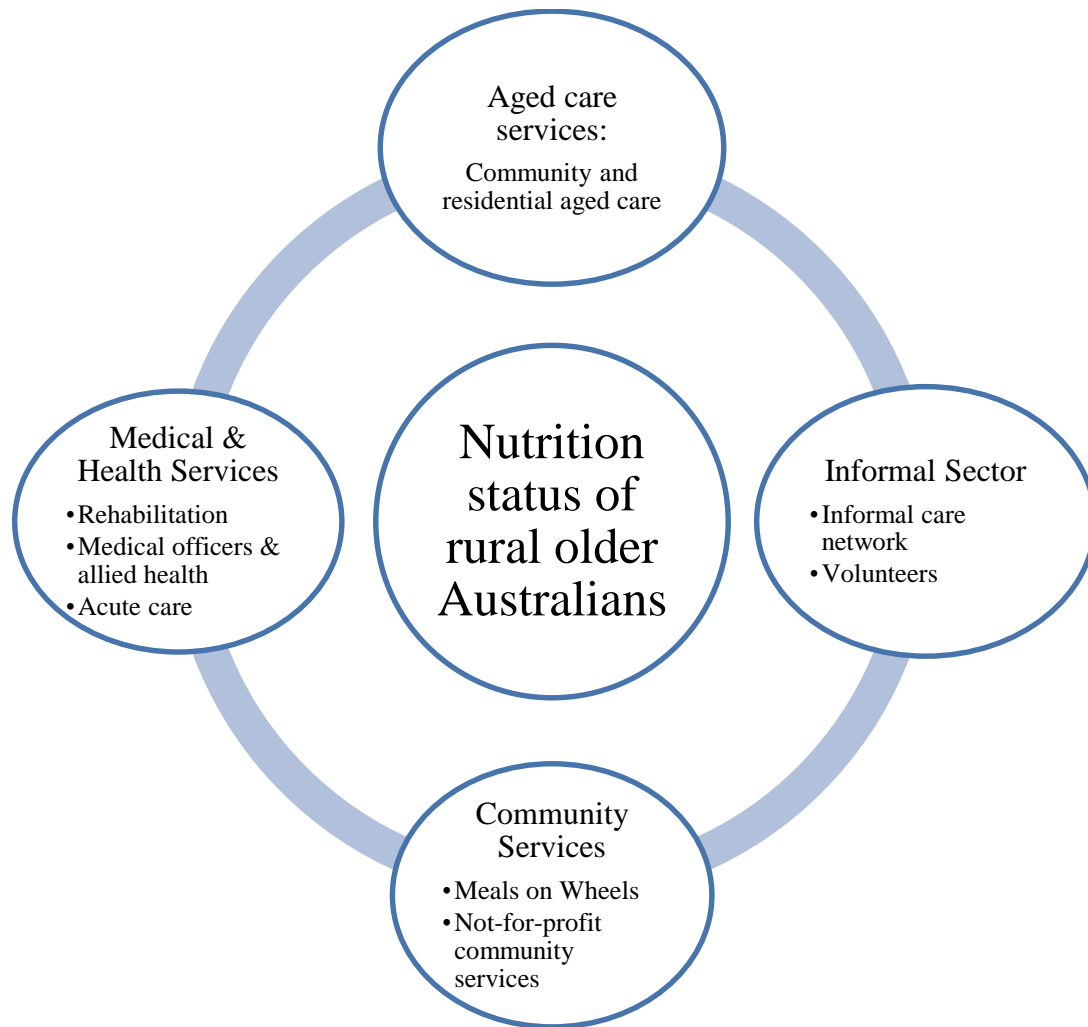


Figure 1.6: Theoretical framework of those who have an influence on the nutritional risk of rural older Australians

CHAPTER 2

PROTEIN-ENERGY MALNUTRITION

Ever since Dr Charles Edwin Butterworth Jr's seminal 1974 article "The Skeleton in the Hospital Closet", there has been a positive movement in clinical health care to address "hospital malnutrition" (Krumdieck, 1998). However, malnutrition remains highly prevalent worldwide in all age groups, in acute care and beyond (Watterson et al., 2009). In highly developed countries, such as Australia, malnutrition is most prevalent in older adults, and it is primarily the role of dietitians to address this condition caused by nutritional imbalance (Watterson et al., 2009).

2.1 Defining malnutrition

Protein-energy undernutrition, also known as protein-energy malnutrition (PEM) and frequently referred to simply as *malnutrition*, occurs when food and nutrient intake is unable to meet protein, energy and nutrient requirements over time leading to an unintentional disruption of homeostasis in lean tissues, body weight and physical function (Pleuss, 2005; Skipper, 2012). Lean tissues include fat-free, metabolically active tissues such as skeletal muscle, viscera, blood cells and the immune system and comprise 35 – 50% of the total body weight of a healthy adult, making lean tissues the largest body component. A decrease in lean tissue is the main cause of weight loss in most cases of malnutrition, although loss of fat mass is also a contributing factor, and is caused by starvation or a combination of starvation and catabolic stress (Pleuss, 2005).

Furthermore, there has been confusion and debate in the literature and in clinical practice regarding malnutrition, starvation, sarcopenia and cachexia in older adults, which are all conditions characterised by involuntary loss of lean tissue (Thomas, 2007). It has been widely recognised throughout history that muscle mass frequently decreases with age; however, determining the correct aetiology and diagnosis for the cause of this loss remains problematic (Tzankoff & Norris, 1978).

2.1.1 Malnutrition or starvation?

Some definitions of starvation are analogous to malnutrition; that is, a chronic inadequate intake of protein and energy, causing a loss of both fat-mass and fat-free mass (Thomas, 2007). Similarly, the Academy of Nutrition & Dietetics (AND) have set out a standardised set of diagnostic characteristics for malnutrition, which allocate three subcategories of the condition based on clinical presentation (White et al., 2012). These are 1) starvation-related malnutrition, 2) chronic-disease related malnutrition and 3) acute disease or injury-related malnutrition (figure 2.1). The AND have defined starvation-related malnutrition as protein energy malnutrition due to pure chronic starvation or anorexia nervosa (White et al., 2012).

A prominent feature of starvation or starvation-related malnutrition is that it is completely reversible by meeting the first phase of digestion, that is the oral phase in which food is chewed and swallowed (Thomas, 2007). However, the term “starvation” differs from “malnutrition” in that it carries with it sociological and environmental implications, such as “famine caused mass starvation” or “thousands died of starvation” (2015g). Overall, starvation may be an important component of malnutrition in some clinical situations, but should be used with caution when discussing PEM in general.

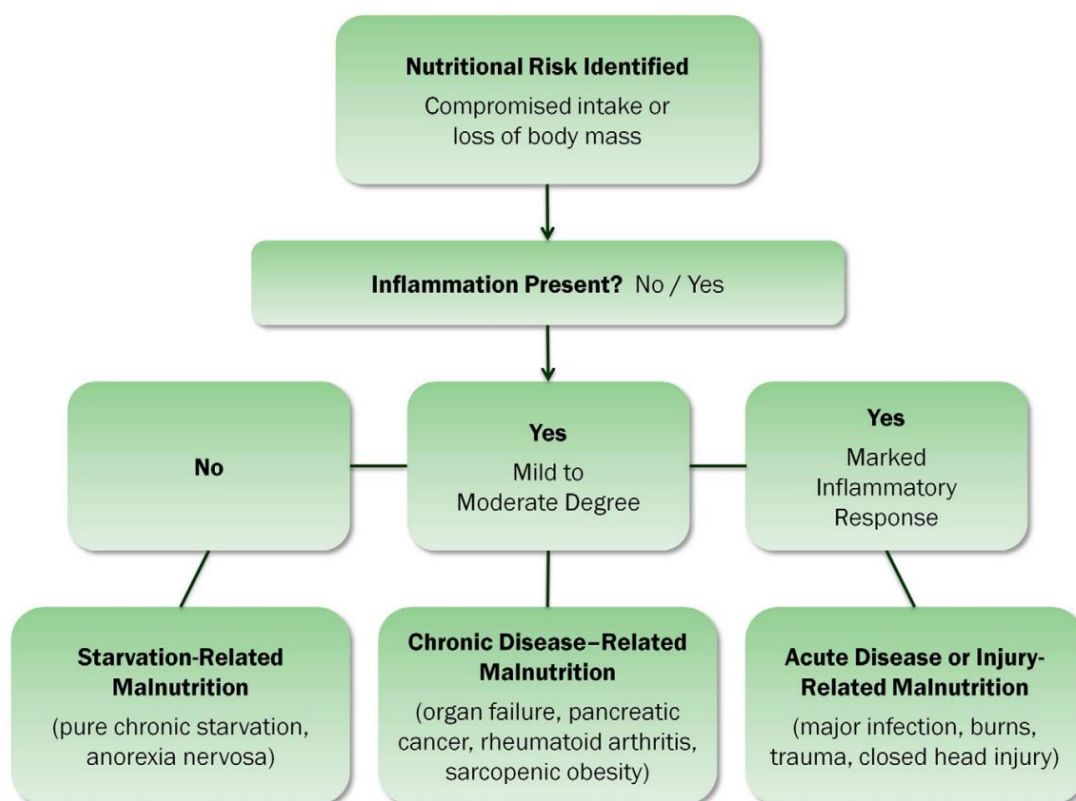


Figure. Etiology-Based Malnutrition Definitions. Adapted with permission from reference (8): Jensen GL, Bistrian B, Roubenoff R, Heimbürger DC. Malnutrition syndromes: A conundrum vs. continuum. *JPEN J Parenter Enteral Nutr.* 2009;33(6):710-716.

Figure 2.1: Etiology-Based Malnutrition Definitions recommended by the Academy of Nutrition and Dietetics (AND) for the identification and documentation of adult malnutrition (White et al., 2012). Included with permission by Elsevier (permissions appendix II).

2.1.2 Malnutrition or sarcopenia?

Since being coined in 1989, the definition of “sarcopenia” has continued to evolve as the condition is further explored (Waters et al., 2010). Early definitions stated it was an age-related decrease in skeletal muscle mass due to a combination of decreased physical activity and/or decreased production of anabolic hormones, but it did not occur in combination with decreased energy intake or weight loss (Evans, 1995). Other definitions

specified that low physical function is a characterising component (Thomas, 2007) and that the condition does *not* respond to nutritional intervention but *will* respond to exercise (Thomas, 2007).

However, in 2009 and 2010 three separate groups of experts met to gain consensus for the definitions of sarcopenia. As each of these consensus definitions were slightly different, no definition is yet universally accepted and there still remains confusion and inconsistency in the literature when describing and diagnosing the “geriatric syndrome” (Cruz-Jentoft et al., 2010b). The European Working Group on Sarcopenia put forward their consensus definition as:

“A syndrome characterised by progressive and generalised loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, poor quality of life and death” (Cruz-Jentoft et al., 2010a).

The International Working Group on Sarcopenia put forward a different but similar definition:

“Sarcopenia is the age-associated loss of skeletal muscle mass and function. Sarcopenia is a complex syndrome that is associated with muscle mass loss alone or in conjunction with increased fat mass. The causes of sarcopenia are multi-factorial and can include disuse, changing endocrine function, chronic diseases, inflammation, insulin resistance, and nutritional deficiencies. While cachexia may be a component of sarcopenia, the two conditions are not the same.” (Fielding et al., 2011)

Finally, the Society for Sarcopenia, Cachexia and Wasting Disorders determined the syndrome should be labelled “sarcopenia with limited mobility”, and defined as muscle loss, low appendicular lean mass and limited walking speed with specific cut-offs for each criterion (Morley et al., 2011). Each group further provided diagnostic criteria for sarcopenia (table 2.1). One important development in the consensus of sarcopenia by the European Working Group on Sarcopenia is the recognition that inadequate dietary intake and/or nutrient malabsorption is a possible factor in the aetiology of the syndrome (known as nutrition-related sarcopenia), along with age-related abnormalities (age-related sarcopenia), endocrine changes, neuro-degenerative diseases or cachexia (disease-related sarcopenia) and muscle disuse (activity-related sarcopenia) (Cruz-Jentoft et al., 2010a). However, both the International Working Group on Sarcopenia and the Society for Sarcopenia, Cachexia and Wasting Disorders did not recognise inadequate nutrition as a potential cause in the multifactorial aetiology of the syndrome, though they did recognise

that it has a role in the pathophysiology of sarcopenia (Fielding et al., 2011; Morley et al., 2011). This may reflect the lack of strong research in exploring the nutritional mechanisms in sarcopenia along with the fact that it may be uncommon to find an older adult with sarcopenia who meets estimated energy and protein requirements (Waters et al., 2010). Emerging research indicates that sarcopenia results in increased protein requirements, and therefore dietary intervention may have an important role in both prevention and treatment (Waters et al., 2010). However, there have not been enough quality studies to conclude whether the severity or progression of sarcopenia is affected by dietary intervention. In addition, it may be possible for both malnutrition and sarcopenia to present as comorbidities, known as the malnutrition-sarcopenia syndrome (MSS) (Vandewoude et al., 2012). It has been recommended that when a patient is diagnosed with malnutrition via a validated nutrition assessment tool such as the Subjective Global Assessment (SGA) or Mini Nutritional Assessment (MNA) that older adults with limited physical function also undergo screening for sarcopenia (low gait speed or poor handgrip strength), in order to diagnose MSS (Vandewoude et al., 2012). However, it must be acknowledged this method of diagnosis has not yet been investigated, and is only a suggested method of diagnosis (Vandewoude et al., 2012).

Table 2.1 Sarcopenia diagnostic criteria according to the European Working Group on Sarcopenia, the International Working Group on Sarcopenia and the Society for Sarcopenia, Cachexia and Wasting Disorders (Cruz-Jentoft et al., 2010a; Fielding et al., 2011; Morley et al., 2011)

European Working Group on Sarcopenia	International Working Group on Sarcopenia	Society for Sarcopenia, Cachexia and Wasting Disorders
Diagnosis is based on the documentation of criterion 1 plus (criterion 2 or criterion 3)	Diagnosis is based upon criterion 1 plus (criterion 2 or criterion 3)	Diagnosis is based upon criterion 1 plus criterion 2
Criterion 1: Low muscle mass (via computed tomography, magnetic resonance imaging, dual energy X-ray absorptiometry or bioimpedance analysis)	Criterion 1: Poor physical functioning (gait speed $<1\text{m}\cdot\text{s}^{-1}$ over 4m)	Criterion 1: Low walking speed ($\leq 1\text{m}\cdot\text{s}^{-1}$ or $<400\text{m}/6\text{min}$) not attributable to disease
Criterion 2: Low muscle strength (via handgrip strength, knee flexion/extension or peak expiratory flow)	Criterion 2: Low whole body lean mass ($<20\%$ ile of values for healthy young adults via dual energy X-ray absorptiometry)	Criterion 2: Low appendicular fat free mass (aLM/Ht^2 of $\leq 2\text{s.d.}$ below healthy persons aged 20-30 years in same ethnic group)
Criterion 3: Low physical performance (via short physical performance battery, usual gait speed, timed get-up-and-go test or stair climb power test)	Criterion 3: Low appendicular fat free mass (in men aLM/Ht^2 of $\leq 7.23\text{ kg}/\text{m}^2$ and in women at $\leq 5.67\text{ kg}/\text{m}^2$ via dual energy X-ray absorptiometry)	

aLM/Ht^2 , appendicular lean mass/ height squared; kg, kilogram; m, meter; $\text{m}\cdot\text{s}^{-1}$, meter per second; s.d., standard deviation.

2.1.3 Malnutrition or cachexia?

Similar to disease-related malnutrition, cachexia is a complex syndrome associated with underlying illness, characterised by the loss of body weight, predominately skeletal muscle, which increases the risk of misdiagnosis (Evans et al., 2008). The 2008 consensus definition of cachexia is:

“Cachexia is a complex metabolic syndrome associated with underlying illness and characterized by loss of muscle with or without loss of fat mass. The prominent clinical feature of cachexia is weight loss in adults (corrected for fluid retention) or growth failure in children (excluding endocrine disorders). Anorexia, inflammation, insulin resistance and increased muscle protein breakdown are frequently associated with cachexia. Cachexia is distinct from starvation, age-related loss of muscle mass, primary depression, malabsorption and hyperthyroidism and is associated with increased morbidity.” (Evans et al., 2008)

Cachexia is further defined by consensus in the form of “cancer cachexia”, the ongoing loss of skeletal muscle mass (with or without fat loss) which cannot be fully reversed by nutrition support and leads to progressive functional impairment. The loss of lean tissues in cancer cachexia is caused by inadequate dietary intake combined with abnormal metabolism (Fearon et al., 2011).

Conditions which predispose to cachexia also increase the risk of malnutrition, including cancer, chronic infection, and chronic kidney disease (Evans et al., 2008). However, unlike malnutrition, the loss of skeletal muscle in cachexia is a result of increased resting energy expenditure mediated by elevated levels of proinflammatory cytokines and a prolonged acute phase protein response (Bauer et al., 2006). Therefore, cachexia is purported to not respond to dietary intervention, and states of malnutrition and sarcopenia have been described as a “pre-cachectic state”, where nutritional intervention may have the most benefit (Evans et al., 2008). However, some research has shown that nutrition intervention may impact upon the pathogenesis of cachexia, although nutrition intervention alone is insufficient to treat the condition (Evans et al., 2008; Isenring & Teleni, 2013; Wilson & Morley, 2003).

2.2 Aetiology of malnutrition

Malnutrition may be both a consequence and a cause of disease (Watterson et al., 2009). The causes of malnutrition may be categorised as a) impaired dietary intake, b) altered metabolic requirements, c) impaired digestion and/or absorption, and d) excessive nutrient losses. However, more than one factor may be responsible (2006b). Furthermore, beyond the physiological causes of malnutrition, there are significant psychological, social and economic factors that influence the risk of malnutrition.

2.2.1 Impaired intake

Sometimes referred to as the ‘anorexia of ageing’, decreased appetite occurs as part of normal ageing (Visvanathan, 2003). Appetite is controlled by interactions between the cortex, limbic system and midbrain as well as peripheral inputs from the gut, adipose tissue and endocrine system (Visvanathan, 2003). These processes may work less efficiently with increasing age leading to consumption of a less varied and lower quality diet (Visvanathan, 2003). However, poor appetite leading to weight loss and/or malnutrition is not part of the normal ageing process and is preventable (Huffman, 2002). Poor appetite in older adults may be attributable to depression, medications, pain, nausea, food aversions, drug addiction, dementia or social causes such as eating alone (2006b; Pleuss, 2005). Furthermore, impaired intake may be caused by an inability to eat which may result from poor dentition, dysphagia, vomiting, altered consciousness or confusion, limb weakness or severe arthritis, inadequate ability to procure or prepare food or medically placed restrictions on intake, for example before surgery (2006b; Pleuss, 2005). Regarding dentition, edentulousness, which is common in older adults, has been found to increase the risk of malnutrition (Saarela et al., 2014). When adjusting for confounders, the risk of malnutrition increased 1.15 times (95%CI 1.06-1.25) for a decrease in masticatory percentage of 10 points (equivalent to the loss of two molars) (Dion et al., 2007).

2.2.2 Altered metabolic requirements

Trauma, sepsis, inflammation, fever and serious illnesses, such as cancer, respiratory disease and acquired immunodeficiency syndrome, increase the body’s metabolic rate and can result in catabolic stress. During catabolic stress there is increased protein breakdown and disrupted protein synthesis. This means the body’s protein cycle is no longer in homeostasis and the net loss of protein in the post-absorptive state is not compensated for by net postprandial gain (Pleuss, 2005). Net protein losses may be up to 20%, which is usually from the breakdown of skeletal muscle but also from organs including the liver, gastrointestinal tract, kidneys and heart (Pleuss, 2005). These hypermetabolic states

increase the requirement for protein, energy and nutrient intake. Medications, polypharmacy and treatments such as haemodialysis can also alter the metabolic requirements for nutrients (2006b).

2.2.3 Impaired digestion and/or absorption

The loss of gastrointestinal integrity as a result of protein catabolism can further exacerbate the protein-energy deficit due to mucosal atrophy and resulting malabsorption (Pleuss, 2005). In addition, there are multiple disease states which may prevent the digestion and/or absorption of nutrients in the gastrointestinal tract (2006b). Acute conditions include bacterial or parasitic infections which may cause gastritis or impair the breakdown of foodstuffs as well as contribute to diarrhoea. Chronic conditions include those that affect the stomach, intestine, pancreas and liver such as cystic fibrosis, inflammatory bowel disease, short bowel syndrome, pancreatitis or liver cirrhosis.

2.2.4 Excessive nutrient losses

Nutrient losses may occur during gastrointestinal dysfunction such as diarrhoea, steatorrhoea and vomiting. Losses also occur through internal or gastrointestinal bleeding, stomas, fistulae or surgically placed drains (2006b).

2.2.5 Psychosocial risk factors for malnutrition

The influence of gender upon risk of malnutrition is unclear, due to the confounding effects of age, medical status and ethnicity (Heersink et al., 2010). However, the characterisation of malnutrition in older hospitalised patients has been found to differ based on gender. Nutritional risk in men has been found to be more often associated with higher depression scores, increased length of stay in hospital and poor appetite; whereas nutritional risk in women was found to be associated with lower functional status and higher number of disease states (Castel et al., 2006). Self-perceived health is often used as an outcome measure in older adult research, as it is influenced by physical function, disease states, disability and the rate of ageing (Ocampo, 2010). Self-perceived health has also been found to influence nutritional risk, perhaps due to its influence on behaviours and attitudes (Heersink et al., 2010).

Living alone, social isolation and socio-economic disadvantage has been found to increase the risk of malnutrition in older adults (Heersink et al., 2010). Indeed, communities in the USA with higher levels of social isolation, such as lack of access to telephones and cars, socioeconomic disadvantage and higher levels of disability among the older adult population were found to have high rates of malnutrition-related mortality (Lee &

Berthelot, 2010). A one standard deviation increase in socioeconomic/physical disadvantage was associated with a 12% increase in the rate of malnutrition-related mortality in older adults ($P<0.001$) using nationally representative data, whereas an increase in social isolation was found to increase risk by 5% ($P<0.05$) (Lee & Berthelot, 2010).

2.3 Physiological and psychosocial consequences of malnutrition

The physiological and psychosocial consequences of malnutrition are significant and diverse. Confusion, fatigue and weakness, common symptoms of malnutrition, are often attributed to other conditions leading to frequent misdiagnosis and under-recognition of malnutrition (Wellman & Kamp, 2008). As described chapter 1.4, malnutrition is under-recognised and under-diagnosed in the acute care, rehabilitation, community and RAC settings (Watterson et al., 2009).

2.3.1 Physiological consequences of malnutrition

Table 2.2 summarises the physiological effects and consequences of malnutrition. The breakdown of liver protein during catabolism inhibits hepatic protein synthesis leading to a decrease in immune cells and serum proteins. This causes anaemia, oedema, poor wound healing and impaired immunity with the consequence of increased susceptibility to infections and pressure ulcers (Pleuss, 2005). Heart function is compromised as cardiac output decreases due to the loss of cardiac muscle (Pleuss, 2005). The ability to control breathing becomes impaired due to the loss of respiratory muscle mass and strength as well as decreased production of surfactant (Mueller, 2008). Malnutrition further affects lung structure, elasticity and immune defence and pulmonary oedema can result due to a decrease in colloidal osmolarity secondary to hypoproteinaemia (Mueller, 2008). The combination of sarcopenia, loss of fat, impaired cardiac and respiratory function and impaired thermoregulation contribute to a significantly increased risk of falls. The combination of decreasing physical function in multiple organ systems as a result of malnutrition increases risk of mortality. Malnutrition was found to be an independent risk factor for six month and one year mortality post discharge from hospital, and is strongly correlated with long-term mortality (Liu et al., 2002; Sullivan & Walls, 1998).

Table 2.2: Physiological effects and consequences of malnutrition (2006b; Ferreira et al., 2011; Martyn et al., 1998; Pleuss, 2005; Stratton et al., 2003)

Adverse effect	Consequence
Impaired immune response	Increased susceptibility to infection and impaired recovery from infection
Impaired wound healing	Surgical wound dehiscence, anastomotic breakdowns, post-surgical fistulae
Reduced muscle mass and strength	Limited physical function, increased disability, increased risk of falls, pressure ulcers, decreased activity leading to increased risk of thromboembolism
Reduced subcutaneous fat for cushioning	Increased risk of fractures in accidents/falls
Reduced respiratory function	Poor cough pressure, increased susceptibility to respiratory infection, fatigue, poor breathing control, pulmonary oedema
Water and electrolyte imbalances	Depletion of potassium, magnesium and phosphate stores combined with excess sodium and water leading to increased risk of re-feeding syndrome and iatrogenic sodium and water overload
Impaired thermoregulation	Hypothermia and increased risk of falls
Vitamin and mineral deficiencies	Specific deficiency states including scurvy and Wernicke-Korsakoff syndrome, iron-deficiency and pernicious anaemia or magnesium deficiency.
Menstrual irregularities	Infertility and osteoporosis
Reduced hepatic function	Anaemia, fatigue, oedema
Reduced cardiac muscle	Decreased cardiac output
Mortality	

2.3.2 Psychosocial consequences of malnutrition

Independent from disease states, individuals who are malnourished may experience a lower quality of life, apathy, depression, self-neglect, hypochondriasis, poor self-efficacy, poor body image, confusion, decreased interest in food, loss of libido and engage less frequently in social activities (2006b; Bottone et al., 2012). Malnutrition may also have an effect upon behaviours and attitudes (2006b).

Depression is prevalent in older adults, with rates of up to 45% in the institutionalised elderly (Jongenelis et al., 2004; Webber et al., 2005). The association between depression and nutritional status is multifactorial and it is unclear if it is a cause and consequence of malnutrition in older adults (Smoliner et al., 2009). Depression is associated with weight loss, and malnourished community-dwelling older adults are more likely to have higher depression scores (Blaum et al., 1995; Cabrera et al., 2007; German et al., 2008; Morley & Kraenzle, 1994).

As a result of these physiological and psychosocial outcomes, malnutrition in the individual leads to decreased physical functioning and quality of life (White et al., 2012). Therefore, malnutrition in the older Australian community needs to be addressed in order to achieve a healthy ageing Australia.

2.4 Economic consequences of malnutrition

The cost of treating a patient with malnutrition in the UK is more than double the cost of treating a well-nourished patient due to the increase use of health-related resources (Guest et al., 2011). Using data on healthcare utilisation by people with malnutrition, it was recently estimated that the cost of treating the health problems associated with malnutrition in the UK is in excess of £13 billion (AUD\$23 billion) per year (Elia & Stratton, 2005). In the USA, disease-related malnutrition in the community setting was found to have an annual burden of USD\$156.7 billion (AUD\$214.7 billion) to society, the large majority of which was due to medical complications associated with malnutrition (Snider et al., 2014).

There is limited research into the economic costs of malnutrition in Australia. However, it has been estimated that malnutrition coded under ICD10-AM cost the Victorian public hospital system \$10.7 million in 2003-04, after controlling for the underlying condition and treatment administered (Rowell & Jackson, 2011). Given that only 2% of inpatients were coded as malnourished (Rowell & Jackson, 2011) this cost appears to be conservative. Recent research has shown that over 30% of acute patients are malnourished according to the ICD-10AM classification of PEM (chapter 2.5.3 below) in a multicentre trial across 56 hospitals in Australia and New Zealand in 2010 (Agarwal et al., 2012). Of the 56 hospitals which participated in the study, 21 hospitals did not code any patients as having malnutrition, and overall only 19% of the malnourished patients were coded as having malnutrition (Agarwal et al., 2014). When malnutrition is properly documented and coded according to the ICD-10-AM, approximately 20% of patients will have a change in their diagnosis-related group, correlating to AUD\$3500 reimbursement per individual (Agarwal et al., 2014).

As suggested by the costs of disease-related malnutrition in the USA, the economic costs of malnutrition must consider malnutrition-related complications such as falls, infections and pressure ulcers. A recent study in 20 public hospitals and six RACFs in Queensland found the economic cost of pressure ulcers attributable to malnutrition in 2002-03 was \$13 million (Banks et al., 2010; Elia & Stratton, 2005; Stratton & Elia, 2010). Malnutrition has also been associated with increased length of stay, rehospitalisation, and greater health care

needs in the community, therefore increasing costs to health care services more broadly (Pleuss, 2005).

Remarkably, screening and monitoring malnutrition accounted for only 4.2% of the total cost of malnutrition, and the cost of treating malnutrition with nutrition support is less than 2.5% of the total expenditure of malnutrition (Elia & Stratton, 2009; Stratton & Elia, 2010; Wilson, 2013). Treating malnutrition is therefore ranked seventh in the top clinical (including medical and pharmaceutical) guidelines shown to produce savings to healthcare by the National Institute for Health and Care Excellence.

2.5 Identifying and diagnosing malnutrition

Due to the importance of preventing, identifying and treating malnutrition in order to maximise patient outcomes, it has been argued that every older inpatient should be screened for the condition, followed by repeated assessments and appropriate treatment (Cudennec et al., 2011). Nutrition screening is the first step in the nutrition care process (appendix III) followed by nutrition assessment. The method of nutrition screening and assessment should be evidence-based and appropriate for the patient group (Watterson et al., 2009). Accurate identification and monitoring of malnutrition are essential steps in the nutrition care process so that patient outcomes may be improved (Lacey & Prichett, 2003).

2.5.1 Malnutrition screening

Nutrition screening aims to identify persons with characteristics commonly associated with nutritional problems who should then go on to have a comprehensive nutrition assessment and intervention (Skipper et al., 2012; Watterson et al., 2009). It should be highlighted that nutrition screening tools determine risk of malnutrition and a diagnosis should not be made using these tools. Screening for malnutrition should occur in all settings: acute care, rehabilitation, RAC and the community; however, tools chosen should be appropriate to the setting (Watterson et al., 2009). There have been two reviews of the validity of nutrition screening tools, which have considered all settings (Skipper et al., 2012; Watterson et al., 2009). These reviews have identified many nutrition screening tools developed to assess the risk of malnutrition, such as the Malnutrition Screening Tool (MST) (Ferguson et al., 1999a), the Simplified Nutritional Assessment Questionnaire (SNAQ) (Wilson et al., 2005), Rapid Screen (Visvanathan et al., 2004), Malnutrition Universal Screening Tool (MUST) (Stratton et al., 2004), and for older adults only, the Mini-Nutrition Assessment-Short Form (MNA-SF) (Rubenstein et al., 2001) and the Seniors in the Community: Risk Evaluation for Eating and Nutrition (SCREEN II) (Keller et al., 2005; Wham et al., 2014).

There has been no study to date which has compared the validity of these tools in the rehabilitation setting.

2.5.2 Malnutrition assessment

Due to the variable temporal and physiological nature of the condition, there is no single parameter sufficiently accurate or reliable as a sole method of diagnosis for malnutrition. In consequence, diagnostic criteria used in clinical practice vary widely leading to confusion and the potential for misdiagnosis. In April 2012, the AND and the American Society for Parenteral and Enteral Nutrition released a consensus statement for characteristics recommended for the identification and documentation of adult malnutrition in routine clinical practice (White et al., 2012). The statement recommends six clinical characteristics, each with specific criteria for several timeframes, to identify non-severe (moderate) and severe malnutrition (appendix IV). These characteristics are 1) insufficient food and nutrition intake compared with nutrition requirements, 2) weight loss over time, 3) loss of muscle mass, 4) loss of fat mass, 5) fluid accumulation (which may mask changes in weight), and 6) measurably diminished grip strength (White et al., 2012). As there are multiple characteristics from which to identify malnutrition, the clinician is able to select one suitable to the patient and setting, for example food intake may be assessed from ward observation in a hospital or nursing home or grip strength may be used during functional assessments for community care. However, it should be noted that the validity of using a single or combination of these characteristics in diagnosing malnutrition has not yet been evaluated.

The development of global nutrition assessment tools such as the MNA (Guigoz et al., 1997; Neumann et al., 2007), SGA (Detsky et al., 1987) and Scored Patient-Generated Subjective Global Assessment (PG-SGA) (Ottery, 2000) are accepted and valid methods of nutrition assessment. Their accuracy and reliability in identifying malnutrition can be attributed to incorporating multiple parameters in their assessment, such as measures of anthropometry, medical status and dietary intake. Although some nutrition assessment tools provide cut-off values within the numerical scoring or global categories for nutrition status, such as the MNA's "well nourished", "risk of malnutrition" and "malnourished", a nutrition diagnosis should be made using the clinical judgement of an appropriately trained health professional, such as a dietitian.

2.5.3 ICD-10-AM

The *International Statistical Classification of Diseases and Health Related Problems 10th Revision, Australian Modification* (sixth edition, ICD-10-AM) criteria are the recognised standard diagnostic criteria for the identification, documentation and coding of PEM in adults (table 2.3). These criteria are used in Australian public health care institutions to provide casemix funding reimbursements associated with diagnosis related group changes in individuals. Failure to identify and document malnutrition in the health care setting can have significant detrimental impacts upon funding (Agarwal et al., 2014). There is no gold standard for diagnosing malnutrition; however, as the ICD-10-AM classification for malnutrition is the agreed upon standard in the Australian health care setting, it has recently been used as the standard against which nutritional screening and assessment tools have been validated (Bell et al., 2014a; Bell et al., 2014b).

Table 2.3: The International Statistical Classification of Diseases and Health Related Problems 10th Revision, Australian Modification (ICD-10-AM) classifications for protein-energy malnutrition for adults (Watterson et al., 2009)

Classification	Definition
E43: Unspecified severe protein-energy malnutrition	In adults, BMI <18.5 kg/m ² or unintentional loss of weight (≥10%) with evidence of suboptimal intake resulting in severe loss of subcutaneous fat and/or severe muscle wasting
E44.0: Moderate protein-energy malnutrition	In adults, BMI <18.5 kg/m ² or unintentional loss of weight (5-9%) with evidence of suboptimal intake resulting in moderate loss of subcutaneous fat and/or moderate muscle wasting
E44.1: Mild protein-energy malnutrition	In adults, BMI <18.5 kg/m ² or unintentional loss of weight (5-9%) with evidence of suboptimal intake resulting in mild loss of subcutaneous fat and/or mild muscle wasting

BMI, body mass index; kg, kilogram; m, meters.

2.5.4 Body mass index

The body mass index (BMI) was first described by Adolphe Quetelet, a Belgian astronomer, mathematician, statistician and sociologist, between 1830 and 1850 (Eknoyan, 2008). The BMI, also known as the Quetelet index, is a relative indication of an individuals or populations size based on mass and height. The BMI is calculated by kg/m², with the resulting units categorised into widely accepted categories of adiposity for individuals (table 2.4). The healthy weight range for an adult population group is 21 – 23 kg/m² (2015e). However, these BMI categories were developed in Western populations (Lew &

Garfinkel, 1979) and have been found to have limitations in certain populations, such as Asian (Tan, 2004), Indigenous Australians (Piers et al., 2003) and older adults.

Table 2.4: Categories of the Body Mass Index (BMI) for adult individuals according to the World Health Organisation (2006a)

BMI Category	Category of Adiposity	Risk to health
$<18.5 \text{ kg/m}^2$	Underweight	Increased mortality and morbidity from causes unrelated to excess fat-mass
$<16 \text{ kg/m}^2$	Severe thinness	
$16.0 - 16.9 \text{ kg/m}^2$	Moderate thinness	
$17.0 - 18.4 \text{ kg/m}^2$	Mild thinness	
$18.5 - 25.0 \text{ kg/m}^2$	Healthy weight	Least risk of chronic disease comorbidities
$25.0 - 29.9 \text{ kg/m}^2$	Overweight / pre-obese	Increased risk of chronic disease comorbidities
$\geq 30 \text{ kg/m}^2$	Obese	Moderate to severe risk of chronic disease comorbidities
$30.0 - 34.9 \text{ kg/m}^2$	Obese class I	Moderate risk of chronic disease comorbidities
$35.0 - 39.9 \text{ kg/m}^2$	Obese class II	Severe risk of chronic disease comorbidities
$\geq 40.0 \text{ kg/m}^2$	Obese class III	Very severe risk of chronic disease comorbidities

kg, kilograms; m, meters.

There are currently no firmly established BMI cut-offs for older adults, however there is strong emerging evidence to suggest that the BMI of $\leq 18.5 \text{ kg/m}^2$ is too low to indicate underweight. In Italian community-dwelling older adults (mean age 81.2 ± 7.3 years), a BMI of less than 22 kg/m^2 was associated with a higher 12-month mortality rate and increased levels of physical dysfunction for both men and women (Landi et al., 1999). In a large study conducted in the USA, the risk of death associated with a high BMI declined with increasing age; however, the absolute increase in death rates associated with a high BMI was highest in older adults (Calle et al., 1999). Despite this high BMI paradox, risk of mortality was found to occur in older adults within the healthy weight range for adults (BMI $18.5 - 25.0 \text{ kg/m}^2$). Specifically, a BMI of less than 20.5 kg/m^2 in men ≥ 75 years had a 20% higher mortality risk, and a BMI $<18.5 \text{ kg/m}^2$ in women ≥ 75 years had a 40% higher mortality risk (Calle et al., 1999).

In 2014, a meta-analysis was published which aimed to define BMI in community-dwelling older adults (≥ 65 years, $n=197,940$ in total) (Winter et al., 2014). There was a U-shaped association between BMI and all-cause mortality, with the lowest risk of death at BMI 24 – 31 kg/m^2 . When compared with a BMI of 23 – 23.9 kg/m^2 , there was 12% increased risk of mortality with a BMI in the range of 21.0 – 21.9 kg/m^2 and 19% greater risk in the range of 20.0 – 20.9 kg/m^2 . Similarly to the USA study, mortality began to increase in risk at a BMI $>33 \text{ kg/m}^2$ (Winter et al., 2014). Winter et al. concluded that a BMI of $<23 \text{ kg/m}^2$ may be considered underweight in community-dwelling older adults (Winter et al., 2014). The Nutrient Reference Values for Australia and New Zealand compiled by the NHMRC state that a BMI of 22 – 27 kg/m^2 may be considered the healthy weight range in the elderly (2005a). However, the document fails to define “elderly” in this context and does not cite literature to support the appointment of this BMI range.

Despite having no clearly defined BMI range for underweight, healthy weight and overweight in older adults, perhaps the criteria of the ICD-10-AM classification of malnutrition is inappropriate for older adults, as a BMI $<18.5 \text{ kg/m}^2$, used to identify long-term or chronic malnutrition, is likely too low. Considering that malnutrition is most prevalent in those aged ≥ 65 years, this is a significant limitation of the coding and will likely have negative implications for funding Australian health services to address malnutrition.

It is also important to acknowledge that being underweight according to the BMI is only one method of identifying malnutrition, and that the condition can occur in healthy weight or overweight/obese individuals (Agarwal et al., 2012). Therefore, BMI may assist in the identification of malnutrition but should not be used as a sole method of screening or diagnosis.

2.6 Malnutrition prevalence in older adults in Australia and internationally

A review of malnutrition prevalence in various settings was published in 2009 and reported the prevalence of malnutrition in acute care to be 20 – 50% (five studies), RACF 40 – 70% (three studies), rehabilitation 30-50% (five studies) and in the community 10 – 30% (three studies) (Watterson et al., 2009). However, there are several limitations of this review which should be noted. Firstly, the search was only conducted up until August 2006 and few prevalence studies were identified. Furthermore, the reporting of prevalence can vary depending on the method used to diagnose the condition as well as the age range or other confounding variables in the particular sample. The prevalence was not reported per

country or region, and the sample characteristics such as age were not described (Watterson et al., 2009). For this reason, it is not possible to make conclusions about the Australian and international prevalence of malnutrition from this review. Therefore, a literature review was conducted and presented below in order to provide an update on the prevalence of malnutrition in Australia and internationally, using only validated methods of malnutrition diagnosis for each setting according to best practice guidelines (Watterson et al., 2009).

2.6.1 Malnutrition prevalence in acute care

In 2010, 3122 patients (64.6 ± 18 years) from 56 acute-care hospitals across Australia ($n=42$) and New Zealand ($n=14$) participated in the Nutrition Care Day survey, which aimed to determine the prevalence of malnutrition (Agarwal et al., 2012). Malnutrition was diagnosed via the SGA (ratings B and C to indicate malnutrition); however, if a patient had a BMI equal to or under 18.5 kg/m^2 they were also considered malnourished. Eight main specialities were represented which were Medical, Surgical, Oncology, Neurology, Orthopaedics, Renal/Urology, Gastroenterology, and Cardiology/Respiratory wards (Agarwal et al., 2012). The ward size ranged from 7 to 54 beds. The study reported the total prevalence of malnutrition was 32%, which is consistent with the reported prevalence in Europe and lower than that reported in Latin America (50%) according to the SGA (Agarwal et al., 2012; Correia et al., 2003; Pirlich et al., 2006). These studies appear to be consistent with the previously reported prevalence of 20 – 50% in acute care (Watterson et al., 2009).

2.6.2 Malnutrition prevalence in residential aged care

A 2013 systematic review reported the prevalence of malnutrition in RAC according to a range of diagnostic criteria, including the MNA and SGA, validated diagnostic tools in this setting (Bell et al., 2013). There were 20 studies reporting malnutrition prevalence in Europe according to the MNA (score <17 to indicate malnutrition), which ranged from 8 – 43% (Bell et al., 2013); however, outliers included 0% and 0.4% in the Netherlands (Essed et al., 2007) and France (Rolland et al., 2007) respectively and 71% in Sweden (Saletti et al., 2000). The prevalence of malnutrition in Asia (27 – 39%) and Canada (31%) was similar to that reported in Europe according to the MNA. Prevalence was higher according to the SGA (ratings B and C to indicate malnutrition) at 50 - 60% in Australia (Gaskill et al., 2009) and the USA (Sacks et al., 2000) in two studies. Therefore, when excluding outliers, the 2009 (reporting 40 – 70% prevalence) review appears to overestimate the prevalence of malnutrition in RAC, where the international prevalence appears to be 10 – 40% according to the MNA and 50 – 60% according to the SGA (Watterson et al., 2009).

2.6.3 Malnutrition prevalence in rehabilitation

Fourteen studies were identified which reported the prevalence of malnutrition in the rehabilitation setting. (table 2.5). Studies were only reviewed where a validated tool was used to assess malnutrition, specifically the MNA (score of <17 to indicate malnutrition), the SGA (ratings B or C to indicate malnutrition) or the ICD-10-AM criteria (E43, E44.0 or E44.1 to indicate malnutrition). BMI was not included as it was considered to not be a true representation of malnutrition prevalence due to the exclusion of normal weight and overweight malnourished patients.

Table 2.5: Prevalence of malnutrition in the rehabilitation setting according to the Mini Nutritional Assessment (MNA), Subjective Global Assessment (SGA) or ICD-10-AM classification of protein-energy malnutrition

Study	Setting	Diagnosis method	Prevalence
MNA in Europe			
(Compan et al., 2000)	<ul style="list-style-type: none"> • France • Sub-acute inpatients • Mean age 83.4±6.8y • n=196 	MNA	33% ^a
(Kaiser et al., 2010)	<ul style="list-style-type: none"> • International collaboration^b • Rehabilitation inpatients • Mean age 74.9±6.2y • n=345 	MNA	40% in men (n=99), 53% in women (n=246)
(Kaiser et al., 2011)	<ul style="list-style-type: none"> • Rome, Italy • Rehabilitation inpatients • Mean age 74.9±6.2y • n=99 	MNA	41%
MNA in Asia			
(Shum et al., 2005)	<ul style="list-style-type: none"> • Regional hospital, Hong Kong • Convalescent and rehabilitation inpatients • Mean age 80.3±7.4y • n=120 	Chinese MNA	17%
(Tsai & Shih, 2009)	<ul style="list-style-type: none"> • Wen-Hua District, Taiwan • Stroke rehabilitation – community and inpatient • Mean age 82% were ≥60y • n=74 • 	MNA, MNA-TI (population specific)	24% (MNA), 14% (MNA-TI)

MNA in Australia			
(Kaur et al., 2008)	<ul style="list-style-type: none"> • Adelaide, SA • Ambulatory rehabilitation^c • Mean age 72y, 95% CI: 70, 74y • n=229 	MNA	5%
(Charlton et al., 2010)	<ul style="list-style-type: none"> • Sydney, NSW • Rehabilitation inpatients • Mean age 80.6±27.7y • n=2076 	MNA	33%
(Visvanathan et al., 2004)	<ul style="list-style-type: none"> • Adelaide, SA • Sub-acute inpatients • Mean age 76.5 – 79.8y • n=65 	MNA	29%
(Neumann et al., 2005)	<ul style="list-style-type: none"> • 3 Hospitals across SA • Rehabilitation inpatients • Mean age 81±6y • n=167 	MNA	0.06%
SGA in Europe			
(Westergren et al., 2001)	<ul style="list-style-type: none"> • Sweden • Stroke rehabilitation inpatients • Mean age 78.62y • n=162 	SGA ^c	32%
(Westergren et al., 2002)	<ul style="list-style-type: none"> • Sweden • Rehabilitation inpatients • Mean age 81.0y • n=520 	SGA ^c	46%
(Andersson et al., 2002)	<ul style="list-style-type: none"> • South Sweden • Rehabilitation inpatients • Mean age 78.5 – 78.6y • n=237 	SGA ^c	34%
SGA in Australia			
(Beck et al., 2001)	<ul style="list-style-type: none"> • Wollongong, NSW • Rehabilitation inpatients • Age not described • n=344 	SGA	49% ^d
(Thomas & Mclean, 2014)	<ul style="list-style-type: none"> • Ballarat, Vic • Sub-acute inpatients • “geriatric”, age not described • n=20 	SGA	65%

CI, Confidence interval; MNA, Mini Nutritional Assessment; NSW, New South Wales; SA, South Australia; SGA, Subjective Global Assessment; Vic, Victoria; y, years.

a Compan et al. (Compan et al., 2000) found that rehabilitation had a higher prevalence than acute care than those in acute care (24.5%) or long-term residential care (24.7%).

b Datasets received from Italy, USA and Australia. The Australian dataset was that of Visvanathan et al. (Visvanathan et al., 2004).

c Receiving rehabilitation services in their homes post-discharge from inpatient rehabilitation.

c The SGA used in Sweden has four ratings of nutrition status, A, B, C and D instead of the usual A, B or C. The authors report malnutrition prevalence comprising ratings B, C and D.

d Beck et al. (Beck et al., 2001) found that rehabilitation had the highest prevalence of malnutrition compared to other inpatient medical wards.

All malnutrition prevalence studies undertaken in the rehabilitation setting have had an older adult and metropolitan sample, however one study did not describe the age of participants (Beck et al., 2001). The two studies which also measured the prevalence of malnutrition in other settings, rehabilitation consistently had the highest prevalence (Beck et al., 2001; Compan et al., 2000). Similarly to the RAC setting, the MNA was the most popular choice internationally for the assessment of nutrition status (n=9 of 13 studies), and no study used the ICD-10-AM to report malnutrition prevalence.

The prevalence of malnutrition according to the MNA varies widely (<1 - 53%), however when viewed by geographical location appears more consistent (33 - 53% in Europe and 14 – 24% in Asia). The exception to this is in Australia, with one study in Adelaide, South Australia, reporting that only 8 in 133 rehabilitation inpatients were malnourished (<1%), however a second study also in Adelaide reported 29% of patients were malnourished only a year before (Neumann et al., 2005; Visvanathan et al., 2004). It is unclear if the large difference in reported prevalence of malnutrition by the MNA is due to a real difference in the severity of malnutrition in each study or due to possible differences in how the tool was implemented. The prevalence of malnutrition according to the SGA was generally consistent from 2001 – 2002 according to studies from Australia and Sweden (32 – 49%), with a small rural study in 2014 indicating a prevalence of 65%. This is therefore consistent with the findings in RAC (chapter 2.6.2), where the MNA appears to report a lower prevalence than the SGA. Further examination of the concurrent validity and reliability of the MNA in the rehabilitation setting, using an appropriate benchmark, is warranted. When

excluding outliers, the prevalence of malnutrition found in this study is 15 – 50% according to the MNA, and 30 – 65% according to the SGA, which does not align with that reported in the 2009 review (30 – 50%) (Watterson et al., 2009).

2.6.4 Malnutrition prevalence in the community

Although the prevalence of malnutrition in the community may be lower than that found in inpatient or residential settings, the largest number of persons with malnutrition are independently living at home (Stratton et al., 2003). Fifteen studies were identified which reported the prevalence of malnutrition in community settings (table 2.6). Studies were only reviewed where a validated tool was used to assess malnutrition, specifically the MNA (score of <17 to indicate malnutrition), the SGA (ratings B or C to indicate malnutrition) or the ICD-10-AM criteria (E43, E44.0 or E44.1 to indicate malnutrition). BMI was not included as it was considered to not be a true representation of malnutrition prevalence due to the exclusion of normal weight and overweight malnourished patients.

Table 2.6: Prevalence of malnutrition in the rehabilitation setting according to the Mini Nutritional Assessment (MNA), Subjective Global Assessment (SGA) or Scored Patient-Generated Subjective Global Assessment (PG-SGA)

Study	Setting	Diagnosis method	Prevalence
MNA in Americas			
(De Marchi et al., 2008)	<ul style="list-style-type: none"> • Carlos Barbosa, Brazil • Mean age 69-70y • n=471 	MNA	1%
(Ferreira et al., 2011)	<ul style="list-style-type: none"> • Sao Paulo, Brazil • Age range 60 – 96y • n=1170 	MNA	2%
MNA in Europe			
(Romero-Ortuno et al., 2011)	<ul style="list-style-type: none"> • Dublin, Ireland • Mean age 72.5±7.1y • n=556 	MNA	0.5%
(Kaiser et al., 2011)	<ul style="list-style-type: none"> • Nuremberg, Germany • Mean age 80.9±5.7y • n=272 	MNA	0%
(Roque et al., 2013)	<ul style="list-style-type: none"> • Catalonia, Spain • Mean age 79.1±7.3y • n=940 with dementia 	MNA	5%
(Rullier et al., 2013)	<ul style="list-style-type: none"> • Rural South West France • Mean age 80.7±6.5y 	MNA	23%

	<ul style="list-style-type: none"> • n=56 with dementia 		
(Droogsma et al., 2013)	<ul style="list-style-type: none"> • Rural Netherlands • Mean age 77.6±5.7y • n=312 with dementia 	MNA	0%
MNA in Asia			
(Iizaka et al., 2008)	<ul style="list-style-type: none"> • Tokyo, Japan • Mean age 72.2±4.3y • n=130 	MNA	0%
(Han et al., 2009)	<ul style="list-style-type: none"> • Wuhan, China • Mean age 74.1±6.0y • n=162 	MNA	8%
(Kaburagi et al., 2011)	<ul style="list-style-type: none"> • Tokyo, Japan • Mean age 76.6±6.3y • n=130 	MNA	2%
(Boulos et al., 2015)	<ul style="list-style-type: none"> • Rural Lebanon • Mean age 75.7±7.1y • n=1200 	MNA	8%
MNA in Australia			
(Visvanathan et al., 2003)	<ul style="list-style-type: none"> • Adelaide, SA • Mean age 79.7±6.8y • n=250 	MNA	Not reported. 43.2% were “malnourished or at risk of malnutrition”
(Rist et al., 2012)	<ul style="list-style-type: none"> • Melbourne, Vic • Mean age 82.0±7.0y • n=235 	MNA	8%
SGA or PG-SGA in Australia			
(Leggo et al., 2008)	<ul style="list-style-type: none"> • Brisbane, Qld • Mean age 76.5±7.2y • n=1145 	PG-SGA	5%
(Sheard et al., 2013)	<ul style="list-style-type: none"> • Brisbane, Qld • Median age 70.0 (range 35-92) • n=125 with Parkinson’s disease 	PG-SGA SGA	15%

MNA, Mini Nutritional Assessment; PG-SGA, Patient-Generated Subjective Global Assessment; Qld, Queensland; SGA, Subjective Global Assessment; y, years.

The MNA was the most frequently used nutrition assessment tool internationally (12 studies), where the SGA and PG-SGA were reported in two Australian studies only. Unlike the rehabilitation setting, the prevalence of malnutrition in the general older adult

community appears to be consistently <10%, with a range of 0 – 8% according to all assessment tools. Some specific high-risk groups, such as samples with dementia or Parkinson's disease had a higher prevalence (range 0 – 23%). Therefore, the 2009 review of malnutrition prevalence in community dwelling adults (10 – 30%)(Watterson et al., 2009) appears to be an overestimation.

However, the prevalence of malnutrition in the community appears to be confounded by sampling procedures, as it is difficult to get an accurate representation of community dwelling adults. For example, Leggo et al. (Leggo et al., 2008) reported a prevalence of 5%, however the participants were first screened by community nursing using the MST, of which only 44% of those at risk of malnutrition consented to a nutrition assessment. Kaburagi et al. (Kaburagi et al., 2011) reported a prevalence of 2%; however, this study relied on volunteers to respond to an advertisement in an elderly care centre causing a bias as non-responders may be those with poorer health. Alternatively, the higher prevalence of 23% reported by Rullier et al. (Rullier et al., 2013) in France sampled community dwelling older adults and their informal caregivers, a population highly engaged with health care and therefore more likely to participate, especially if the informal caregivers were experiencing feeding difficulties.

Bias may be introduced by sampling the population from community care or community nursing agencies, as only older adults with acknowledged requirement for greater assistance will be receiving services, as is the case reported by Rist et al. (Rist et al., 2012) in Melbourne, Victoria. The study by Ferreira et al. (Ferreira et al., 2011) in Sao Paulo, Brazil, was completed in a random population sample of community dwelling older adults who participated in the Health, Well-being and Ageing survey, and may therefore be the best representative of a true malnutrition prevalence. However, socio-economic factors make it likely that prevalence may vary across the world and in rural compared with metropolitan areas.

It is clear that malnutrition is highly prevalent in the acute and longer term care settings, including both rehabilitation and RAC. Although prevalence is small in the community, as a percentage of the total population there are a large number of older adults with malnutrition. In contrast to the acute care setting, settings such as rehabilitation, RAC and the community provide opportunity for longer term management of malnutrition and gains in health outcomes. For this reason, the relationship between these long-term settings warrants further exploration.

2.7 Treating malnutrition

2.7.1 Role of the dietitian in the multidisciplinary team

The DAA states “The profession of dietetics contributes to the promotion of health and the prevention and treatment of illness by optimising the nutrition of populations, communities and individuals. Dietitians have a defined and recognisable body of knowledge and utilise scientific principles and methods in the study of nutrition and dietetics, applying these results to influence the wider environment affecting food intake and eating behaviour. The scope of dietetic practice is such that dietitians may work in a variety of settings and have a variety of work functions.” (2013c). Therefore a dietitian is ideally placed to address malnutrition.

The expertise of a dietitian is required in order to identify underlying aetiology, assess the nutrient requirements of the patient, make a plan for providing the required nutrients and to monitor the patients response to the treatment provided (Lacey & Prichett, 2003). However, it is essential that the dietitian liaise with the multidisciplinary team which may include allied health professionals such as speech pathologists and social workers, medical officers including general practitioners and gastroenterologists, nursing staff, support staff including domiciliary caregivers and nutrition assistants and the patients’ informal caregivers. This nutrition care team will vary in composition based on the setting and resources available. In addition, the team needs to be supported by appropriate health and community services in order to ensure food security, provide adequate access to medical and health services, provide financial support and access to aged care programs.

2.7.2 Evidence for the treatment of malnutrition in the rehabilitation and community settings

Malnutrition is preventable and treatable, and in some instances is a completely reversible condition. From the physiological standpoint, malnutrition can be treated by providing the energy, protein and micronutrients required to meet physiological need (Wellman & Kamp, 2008). The additional nutrients can be provided by 1) oral dietary intake, such as providing a high protein-high energy (HPHE) diet; 2) oral nutrition supplements (ONS), usually a liquid based formula with high concentrations of nutrients; 3) enteral nutrition, liquid nutrient supplements delivered to the gastrointestinal tract via tubes inserted in the nose, oral cavity or through the abdominal wall; and 4) parenteral nutrition, nutrients delivered directly into the blood stream (Mueller & Bloch, 2008).

However, the treatment of malnutrition is complicated by its multifactorial aetiology, and all contributing factors, both physiological and psychosocial, must be addressed in order for improved patient outcomes. For this reason, it is essential that the condition is addressed by a multidisciplinary team with the support of the health care system, the community and society in general.

The 2009 *Evidence Based Practice Guidelines for the Nutritional Management of Malnutrition in Adult Patients Across the Continuum of Care* found that, in the rehabilitation setting, there is evidence that modifying the method of food provision (such as a HPHE diet) will result in improved energy (level II evidence; appendix I) and protein intake (level III-2 evidence). The provision of liquid ONS was found to improve complications and length of stay (level I evidence), weight status, body composition and physical function (level II evidence), and nutritional biochemistry and self-rated wellbeing (level IV evidence) (Watterson et al., 2009). A 2015 systematic review and meta-analysis found evidence that the provision of ONS significantly improved energy and protein intake in older rehabilitation patients at risk of malnutrition or malnourished, which in turn improved weight and fat free mass, arm muscle circumference, physical function and length of stay (Collins & Porter, 2015).

Meal modification, such as energy and protein fortified meals and snacks and/or provision of a hot cooked breakfast was also found to improve energy and protein intake; however, did not affect weight status. This may be because the provision of the fortified snacks did not improve energy and protein intake to the same degree as ONS (Collins & Porter, 2015). In addition, the review found that following the nutrition care process (appendix III) (Lacey & Prichett, 2003) in rehabilitation, which involved nutrition screening by nursing staff followed by nutrition assessment, individualised intervention and follow-up by a dietitian, improved energy and protein intake, nutrition-related biochemistry and quality of life in malnourished older adults. Alternatively, nutrition assessment and intervention provided by specially trained nurses resulted in no improvements, highlighting the importance of dietitians as specialists for treating malnutrition in rehabilitation (Babineau et al., 2008; Collins & Porter, 2015).

In the community setting there is evidence that modifying the method of food provision will result in improved weight status (level III-2 evidence) and global nutrition status (level IV evidence). The provision of liquid ONS was found to improve weight status (level I evidence), energy intake, body composition and physical function (NHMRC level II

evidence) and cognition and quality of life (level IV evidence) (Watterson et al., 2009). A systematic review of nutrition-related randomised controlled trials (RCTs) in community setting was undertaken in 2011 (Bandayrel & Wong, 2011). Although 15 RCTs were included in the review, only two trials addressed malnutrition, both through the provision of ONS. These two trials saw no significant improvements in physical function or anthropometry; however, did report lower incidence of falls and days spent in bed, and improved emotional role-functioning (Gray-Donald et al., 1995; Payette et al., 2002).

Despite the research done in this area, malnutrition interventions such as nutrition counselling and medical nutrition therapy by a dietitian, feeding assistance, management by a nutrition support team, enteral nutrition, parenteral nutrition and malnutrition education in the rehabilitation and community settings do not have high quality of evidence for their efficacy (Watterson et al., 2009). This does not mean that these strategies are not employed by practitioners nor that they are ineffective for improving the nutritional status of the patient; but rather the strategies have not been evaluated in the published literature. This may have a significant impact upon the Australian dietitian workforce in these settings, as there is increasing need to justify the role of dietitians for resource allocation.

Although dietitians currently practise as part of nutrition care teams in addressing malnutrition in this area, evidence is needed of the effectiveness of a nutrition care team and the role of the dietitian in treating malnutrition in the rehabilitation and community settings (Watterson et al., 2009). Overall, despite malnutrition being of “high interest” since 1974, there is still a lack of evidence regarding the extent of the problem and the best method of treatment in the rehabilitation and community settings.

2.7.3 Evidence for the treatment of malnutrition in residential aged care

Although previously community-dwelling older adults may wish to return home after a hospital or rehabilitation admission, this may not be appropriate for some individuals due to increased care requirements. Research has found that approximately 12 - 30% of community-dwelling older Australians are discharged to an RACF from rehabilitation facilities (Charlton et al., 2012; Lindenberg et al., 2014). Predictors of discharge to RAC include having no family support, having bladder catheterisation, dysphasia and cognitive decline (Massucci et al., 2006; Wee et al., 1999). In addition, poor nutritional status is associated with increased risk of discharge to RAC in community-dwelling older adults as well as discharge to a higher level of care for already institutionalised older adults (Charlton et al., 2012; Neumann et al., 2005). Preventing malnutrition and treating malnutrition in RAC will help prevent residents requiring a higher level of care, and may have other

benefits for the resident and aged care facility, such as prevent the need for hospitalisation. In order to examine malnutrition in the RAC setting, an invited narrative review was undertaken by the PhD candidate and colleagues. Specifically, the review examined the aetiology, consequences (from chapter 2.3), prevalence and identification of malnutrition, as well as current evidence for the prevention and treatment of malnutrition in RACF.

2.7.3.1 Publication

Agarwal E, **Marshall S**, Miller M, Isenring E. (2016) Optimising nutrition in residential aged care: A narrative review. *Maturitas*, In press. DOI: 10.1016/j.maturitas.2016.06.013. The latest submitted version of this manuscript (following peer review, prior to publication) has been included in appendix V.

2.7.3.2 Statement of contribution to publication by authors

Ekta Agarwal developed the study concept, analysis and primary drafting of the malnutrition identification, prevalence and aetiology sections of the manuscript. Skye Marshall contributed the consequences of malnutrition (excerpt from chapter 2.3) and conducted the literature review, analysis and drafting of the management of malnutrition section. Ekta Agarwal and Skye Marshall drafted the implications for practice and research section. Elizabeth Isenring further contributed to the study concept and the aetiology of malnutrition section. Michelle Miller contributed to the study concept. All authors contributed to manuscript revision.

2.7.3.3 Conclusion and implications of findings

Although malnutrition in the RAC setting is theoretically highly manageable, due to increased opportunities for nutrition screening and having a much larger influence over food provision, the reality is that it is largely undiagnosed and that nutritional intervention appears to be a low priority, leading to a continued high prevalence internationally. The current body of evidence suggests that an emphasis should be placed on prevention of malnutrition through ensuring food security by means of providing liberalised meals and snacks which align with the cultural, social and psychosocial needs of residents. Measures such as these are highly cost-efficient; however, will require significant changes to food and nutrition policy and the physical arrangement of dining areas, as well as significant staff training and education. These initial costs and activities may present a significant barrier to many RACFs, and therefore there is a need for robust studies examining the cost-effectiveness of such interventions in the short- and long-term to encourage their implementation. However, the current evidence identifies immediate opportunities such as implementing a nutrition policy which includes regular nutrition screening, referral of at

risk residents to a dietitian for nutrition assessment, provision of low-volume ONS at mid-meals, encouragement of physical activity, with regular in-service education for staff and the appointment of a nutrition champion.

2.8 Conclusion

Malnutrition is distinct from sarcopenia and cachexia, where nutrient intake is critical in the pathophysiology of the condition. The causes of malnutrition are multifactorial, and are influenced by the physiological condition of the patient, their environment, and psychological, social and economic background (chapter 2.2). Although treatment of malnutrition is theoretically simple through the provision of appropriate nutrition support, the diverse and interrelated risk factors make the condition difficult to identify and treat, leading to a high malnutrition prevalence in acute care, rehabilitation, community and RAC settings (chapter 2.6).

In order to effectively prevent and treat malnutrition, the nutritional journey that older adults make across the continuum of community, health and aged care settings must be further explored, with these longer term settings providing increased opportunity for management. It is clear that older Australians prefer to remain in their own homes (chapter 1.2). In order to support the Australian government's Living Longer, Living Better, Aged Care Reform Package (2012c), nutrition interventions should be primarily focussed on supporting community-dwelling older adults to prevent or delay their need for institutionalisation.

If hospitalised older adults, both living in the community or RAC, are not independent enough to be discharged they are frequently admitted to sub-acute rehabilitation units. This explains the high prevalence of malnutrition at admission to rehabilitation in older adults (chapter 2.6.3), as malnutrition is known to decrease physical function and independence (chapter 2.3.1). Therefore, identifying strategies to improve the nutrition status of older adults in the rehabilitation setting will provide important opportunities to help meet the demands of the ageing population, by supporting ageing in place or lower levels of care.

Therefore, reflecting on the challenges posed by an ageing Australia and the requirement to address malnutrition (chapters 1 and 2), there are many opportunities for research to inform and improve best practice for the management of malnutrition across the continuum of care. One of the greatest of these opportunities is to support older adults in rehabilitation and on their return home. The purpose of rehabilitation is to improve the independence of older adults, and it will consequently grow in importance as the proportion of older

Australians increases. Long-term settings such as rehabilitation and the community provide significant benefits to practitioners, as the longer length of stay and home environment allow for the engagement of the patient and their caregivers to implement long-term nutrition interventions. Non-clinical caregivers such as community care workers and informal caregivers can have a significant impact upon the nutrition status of older adults, and have a high level of engagement with their care-recipient (chapters 1.2.5 and 1.4.1). Research is therefore required to determine the best methods of malnutrition identification and management in the rehabilitation and community settings. Additionally, research is needed which explores the relationship between the two settings, and the potential for nutrition care teams which involve not only the patient and their health professionals, but also community and informal caregivers.



PART II

SYSTEMATIC LITERATURE REVIEWS

CHAPTER 3

CAREGIVER NUTRITION EDUCATION AND ITS EFFECT ON CARE-RECIPIENT AND CAREGIVER OUTCOMES

3.1 Preliminary exploratory literature review

A preliminary exploratory literature review was conducted to identify current interest and evidence regarding informal caregiver and non-clinical care worker health-related education. Intervention studies which aimed to improve the health status of either caregiver or care-recipient were of interest.

3.1.1 Search strategy

Published English-language literature from 1980 to March 2012 from two health-related electronic databases, PubMed and CINAHL, was searched. The keyword search terms included the combinations of *carer* with *community*, *education* and *training* both with and without *nutrition*. The reference lists of identified articles were also searched for relevant articles.

3.1.2 Selection strategy and procedures

Studies were included if they described the development of, reviewed or implemented, health-related education to informal caregivers (family or friends of care-recipient) and non-clinical care workers (paid caregivers with no health-related education). Inclusion criteria were that the care-recipients were community-dwelling and older adults (>65 years).

3.1.3 Quality assessment

Strength of evidence was assessed using the NHMRC levels of evidence according to type of research question (Coleman et al., 2005). Quality of evidence was assessed using the AND (previously American Dietetic Association) Quality Criteria Checklists for primary research or review article where appropriate, and designated with a positive (+, strong quality), neutral (Ø, neither strong nor weak quality) or negative (-, weak quality) assessment.

Table 3.1: Evidence summary of health education provided to informal caregivers and non-clinical care workers of community-dwelling older adults

Citation & Country	NHMRC Level	AND Quality	Study Design & Sample	Methods	Outcomes & Results
Studies with nutrition related outcomes					
(Parker et al., 2008) International	I – intervention evidence RCTs most common (32.5%)	+	<i>Effectiveness of interventions to assist caregivers of community dementia patients</i> · Systematic review and meta-analysis · 40 papers included	1) Inclusion criteria: adult caregivers who provide support for community-dwelling persons with dementia; all study types; 2) Search strategy: 2000 – 2005, English, CINAHL, MEDLINE, PsychINFO using MeSH headings and keywords, followed by hand searching reference lists 3) Quality assessed by JBI critical appraisal check list	85 papers met inclusion criteria and 40 reviewed including systematic reviews, meta-analysis and RCTs · Psycho-educational interventions: no impact on subjective wellbeing, self-efficacy or health. Small significant benefits on depression and burden · Support interventions: small significant improvement on burden (in 2 of 7 studies only) · Multi-component interventions: significant effect on self-efficacy, depression, subjective wellbeing and burden · Exercise and nutrition: improvements in psychological distress and health benefits. Case management and computer aided support had mixed results. Cognitive behavioural therapy reduced anxiety · Meta-analysis: showed positive effect of intervention on caregiver depression but no effect on caregiver burden

Citation & Country	NHMRC Level	AND Quality	Study Design & Sample	Methods	Outcomes & Results
(King et al., 2002) USA	II – intervention evidence	N/A ^a	<i>Physical activity and nutrition program for older female caregivers</i> <ul style="list-style-type: none"> Randomised controlled trial n=100 49 – 82y 	1) Intervention group: home-based, telephone supervised, moderate intensity exercise training 2) Control: nutrition education program	Baseline, +12m <ul style="list-style-type: none"> Stress-induced SBP reactivity levels: Improve significantly in PA group (reduction of 12mmHg), stable in control Rated sleep quality: PA group improved significantly compared with control Reported psychological distress: Both groups improved Dietary intake: control improved significantly (energy, total fat, SFA) compared with PA group
(Francis & Taylor, 2009) USA	II – intervention evidence	Ø	<i>Nutrition education for health heart choices for caregivers</i> <ul style="list-style-type: none"> n=58 54 – 83y (100% female) 	1) In-home dietitian-led education on healthy heart nutrition practices 2) Dietary intake assessed using three 3d food records (9d total)	-1m, Baseline, +1m, +2m. <ul style="list-style-type: none"> Improve dietary compliance to healthy heart choices: all participants ‘somewhat compliant’ at all measures (pre and post intervention) Improve attitudes and morale to healthy heart choices: Morale improved in both groups and was significantly related to Efficacy Improve self-efficacy (efficacy scale): no changes

Citation & Country	NHMRC Level	AND Quality	Study Design & Sample	Methods	Outcomes & Results
(Salva et al., 2011) Spain	II – intervention evidence	+	<i>Health & nutrition education to physician, informal caregiver & dementia patient</i> <ul style="list-style-type: none"> Cluster (medical facility) randomised controlled trial Community-dwelling n=946 Attrition rate: 31% μ79.0y 	1) Participants had dementia with identified caregiver, in-home, ambulatory. 2) NutriAlz Program: delivered to physicians and caregivers - included resources on AD, nutrition, physical activity; presentations by dietitian; register for caregivers; action protocols.	Measured at baseline, +6m, +12m. Physical function (ADL & IADL): no significant change – maintenance of autonomy achieved over 12m Nutrition status (MNA): significant improvement of μ0.46 (95% CI 0.09 – 0.83) in intervention group; control group declined -0.66 (95% CI -0.8 - -0.21) ($P=0.028$) Weight change: no significant change – both groups maintained weight. No change in BMI Caregiver burden (Zarit scale): no difference between groups observed Healthcare costs & utilisation – results not reported

Citation & Country	NHMRC Level	AND Quality	Study Design & Sample	Methods	Outcomes & Results
(Riviere et al., 2001) France	III-2 intervention evidence	Ø	<i>Nutrition education to Alzheimer's caregivers.</i> <i>Caregivers = family</i> · Non-randomised, experimental trial: controlled before-and-after study. · n=225 · Attrition rate: 5%	1) Nine sessions of 1h spread over 12m delivered to caregivers. Group education 2) Control group caregivers offered advice provided in normal follow-up	Measured at baseline and +12m. Weight measured also at +6m. · Weight loss prevention: weight increased ($0.7 \pm 3.6\text{kg}$) but decreased in control ($-0.7 \pm 5.4\text{kg}$) ($P < 0.05$). After adjusting for baseline differences the weight change was not significant · Nutrition status (MNA): status maintained but decreased in control (-0.1 ± 3.4) ($P < 0.005$) · Autonomy (ADL, IADL): no change · Cognitive function (MMSE): intervention group decline was slower · Caregiver burden (Zarit): Stable in intervention, increased in control but not significant · Caregiver nutrition knowledge: increased significantly ($P < 0.005$)

Citation & Country	NHMRC Level	AND Quality	Study Design & Sample	Methods	Outcomes & Results
(Paul et al., 2000) USA	IV – intervention evidence	-	<i>Nutrition education to rural caregivers of patients with dementia</i> • Case series: post-test • n=23 communities received broadcast	1) 90-minute program delivered via interactive videoconference with a panel, participants could call with questions 2) Promoted by relevant persons in rural communities, technicians at each site to set up 3) A follow-up of handouts and video scenes distributed to centres	Evaluation survey, n=66 responses 97% overall rated good or better Rated as convenient and practical Technical difficulties prevalent
Studies with no nutrition related outcomes					
(Mittelman et al., 1993) USA	II – intervention evidence	+	<i>Counselling intervention to spouse caregivers of patients with dementia</i> • Randomised controlled trial • n=206 spouses • 87% ≥60y • Attrition rate: 9%	1) Controls received usual care – counsellor access and handouts 2) Intervention received intensive individualised counselling – in home or at institution	Baseline, +12m. Institutionalisation: Decreased rates in intervention group (less than half of that of control) (OR 0.40, $P < 0.05$) and in those who joined support groups in both groups Lower patient income (OR 0.96 $P < 0.05$) and increased patient age (OR 1.10 $P < 0.05$) associated with increased rates

Citation & Country	NHMRC Level	AND Quality	Study Design & Sample	Methods	Outcomes & Results
(Coen et al., 1999) Ireland	IV – intervention evidence	Ø	<i>Dementia caregiver education, psycho-social. Caregivers = family</i> <ul style="list-style-type: none"> Case Series: Pre-test/post-test Convenience sample n=32 Attrition rate: 17.5% 	1) Eight weekly 2h education and support sessions run by psychogeriatric team. Group education	Measured baseline and +6m. Caregiver QoL: no change ($P = 0.42$) or worse ($P = 0.060$) Caregiver burden: increased ($t = 2.82$. $P = 0.009$) Caregiver well-being: no result reported Caregiver knowledge of dementia: increased ($P < 0.0001$)
(Dicker et al., 2005)	IV – intervention evidence	-	<i>Caregiver training regarding behavioural & psychological symptoms of dementia</i> <ul style="list-style-type: none"> Case Series: Pre-test/post-test n=50 caregivers Attrition rate: 26% μ63y 	1) Training package, modular approach: individual training with trainer's manual, training booklets for caregivers, client help-sheets for further reference 3) Questionnaire on stress, general health, behaviour rating	Measured baseline, +6m, +12m. Increases in caregiver's self-perceived knowledge of dementia, management, caring ability and stress reduction however caregiver stress returned to pre-intervention levels 12m post intervention Measures of outcomes were not objectively measured by standardised tools

Citation & Country	NHMRC Level	AND Quality	Study Design & Sample	Methods	Outcomes & Results
(Higgins & Barkley, 2004) USA	N/A – non-systematic review	-	<i>Barriers to educating older adults</i> · Literature review · ≥60y · Independent living citizens of USA only	1) Barriers to training educating health professionals, volunteers, caregivers, and older adults 2) Published 1993 – 2003 3) Excluded: intensive individualised counselling, public health education, nutrition screening studies. No exclusions due to quality	· 30 papers identified · Barriers for healthcare professionals: misconceptions and stereotypes of older adults (ageism), limited knowledge of ageing process/concerns, lack of attention, lack of funding, difficulty recruiting · Barriers for older adults to respond: attitudinal, motivational, environmental, low literacy and poverty · Training volunteers/non-clinical care workers: benefits and limitations need to be studied, train-the-trainer group education acceptable to older adults (1 study), hands-on/visual education acceptable (2 studies) · Training informal caregivers: resource Home Health Nutrition: Patient Education Manual (Aspen Reference Group, 1998) exists; satellite teleconferencing for rural caregivers

AD, Alzheimer's disease; ADL, activities of daily living; AND, Academy of Nutrition & Dietetics; BMI, body mass index; d, day; h, hour; IADL, instrumental activities of daily living; JBI, Joanna Briggs Institute; m, month; MNA, Mini Nutritional Assessment; N/A, not available; NHMRC, National Health and Medical Research Council; OR, odds ratio; PA, physical activity; QoL, quality of life; RCT, randomised controlled trial; SBP, systolic blood pressure; SFA, saturated fatty acids; USA, United States of America; y, year.

a Assessment not possible as only abstract was available for review.

3.1.4 Results and discussion

Twenty-three articles were extracted for review, of which 13 were excluded as they did not meet the inclusion criteria. The 10 articles reviewed are summarised in table 3.1. A systematic review by Parker, et al (Parker et al., 2008) was the only article considered level I evidence. There were four RCTs (level II evidence) (Francis & Taylor, 2009; King et al., 2002; Mittelman et al., 1993; Salva et al., 2011); however, only two of these were considered to have positive quality (Mittelman et al., 1993; Salva et al., 2011). The RCT by King, et al (King et al., 2002) could not be reviewed for quality as only the abstract was available. Overall the quality of the literature identified was poor with six of nine assessed as being negative or neutral quality.

No papers were identified which provided education to non-clinical care workers. It appears that research in this topic is primarily concerned with educating informal caregivers of patients with dementia, with seven of the 10 studies reviewed involved family caregivers of dementia patients, including the systematic review which included 40 papers on this topic.

Five of the studies identified only addressed caregiver outcomes. The most common outcome of interest in caregivers was caregiver burden as measured by the Zarit scale; however, caregiver knowledge, quality of life and self-efficacy were also of interest. The only two interventions which were focussed on caregiver health were a healthy heart nutrition education program by Francis and Taylor (Francis & Taylor, 2009) and a physical activity program by King et al (King et al., 2002). Other studies which aimed to improve caregiver-related outcomes did so by providing education to assist in the care of the care-recipient. These later studies resulted in significantly increased caregiver knowledge (Coen et al., 1999; Dicker et al., 2005; Riviere et al., 2001) although there was either no change (Riviere et al., 2001; Salva et al., 2011) or an increase in caregiver burden (Coen et al., 1999) and no change in quality of life (Coen et al., 1999).

Six studies were concerned with nutrition-related outcomes for either the caregiver or care-recipient (table 3.1). Where dietary intake was considered, methods of dietary assessment were either not reported (King et al., 2002) or were unreliable or not validated (Francis & Taylor, 2009). The RCT by Salva et al (Salva et al., 2011) was the only intervention concerned with malnutrition in this at-risk population. This study provided good quality evidence that educating informal caregivers of older adults can result in improved nutritional status in care-recipients, and prevent decline in weight and functional status. It

is important to note however that this study was aimed at physicians and informal caregivers and the influence of the caregiver on these results is unknown.

3.2 Are informal caregivers and community care workers effective in managing malnutrition in the older adult community? A systematic review of current evidence

3.2.1 Introduction

Chapters 1 and 2 have shown that enhancing the nutrition care process (appendix III) to prevent and treat malnutrition in community-dwelling older adults should feature in future health care policy in order to reduce hospital and aged care facility demand.

A study in South-East Queensland found that 15% of HACC clients (n=1145) were at risk of malnutrition using the MST and 5% were diagnosed as malnourished via the PG-SGA (Leggo et al., 2008). A more recent study in Victoria, Australia, found that 35% of older adults (n=235) receiving home nursing services were at risk of malnutrition using the MNA and a further 8% were malnourished (Rist et al., 2012). Despite the significant social, economic and physical consequences of malnutrition and high prevalence in the older population, there is level I evidence to show malnutrition is under-recognised and under-diagnosed in the community setting; therefore no clear recommendations can be made regarding frequency and method of malnutrition screening nor treatment protocols (Watterson et al., 2009).

Ageing populations increase pressure on resourcing adequately trained health professionals in the aged and health care sectors (2011c). In response to these workforce pressures, the aged care sector has been moving towards a more streamlined, lower cost workforce by utilising non-clinical staff, which currently make up the majority of the workforce (2012c). Nutritional outcomes in older adults may be influenced not only by health professionals but also by their informal caregivers, such as spouses, and non-clinical community care workers; however, there is limited research in this area (Cho, 2007; Silver & Wellman, 2002a). Indeed, many nutritional services which help to prevent malnutrition and are valued by older adults do not require the expertise of a dietitian or physician. These may include providing nutrition brochures and linking clients to services (Mudge et al., 2012), which may be provided by nutrition care volunteers or skilled support workers. Therefore the inclusion of informal caregivers and non-clinical community care workers in the nutrition care team contributes to the effectiveness of the workforce. With assistance from support workers, health professionals can utilise their full scope of practice to provide appropriate care. The exploratory review reported in this chapter indicates that educating informal caregivers of older adults may improve patient outcomes. However, it is unclear

to what extent these caregivers are able to affect malnutrition-related outcomes in community-dwelling older adults. Therefore, a systematic review of the literature was undertaken which aimed to investigate the impact of nutrition-related interventions delivered to or by informal carers and non-clinical community care workers on malnutrition-related health outcomes of community-dwelling older adults (≥ 65 years).

3.2.2 Publications

Marshall S, Bauer J, Capra S, Isenring E. (2013) Are informal carers and community care workers effective in managing malnutrition in the older adult community? A systematic review of current evidence. *The Journal of Nutrition, Health & Aging* **17**, 645-651⁴. DOI: 10.1007/s12603-013-0341-z. Included with permission by Springer (permissions appendix VI). *Number of citations by date of thesis submission: 9.*

This study has also been published and presented elsewhere:

- *Published abstract:* **Marshall S**, Bauer J, Capra S, Isenring E. Are informal carers and community care workers effective in managing malnutrition in the older adult community? A systematic review of current evidence [Abstract]. *Nutrition & Dietetics*. 2013;70 (S1):15.
- *Oral presentation:* **Skye Marshall**, Judith Bauer, Sandra Capra, Elizabeth Isenring. Are informal carers and community care workers effective in managing malnutrition in the older adult community? A systematic review of current evidence. 30th DAA National Conference, Canberra, 22 – 25th May 2013. *Oral presentation featured in plenary session “Best of the best” (appendix XIII).*

⁴ Page numbers of the featured publication correspond with the journal publication and not with this thesis.

ARE INFORMAL CARERS AND COMMUNITY CARE WORKERS EFFECTIVE IN MANAGING MALNUTRITION IN THE OLDER ADULT COMMUNITY? A SYSTEMATIC REVIEW OF CURRENT EVIDENCE

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Abstract: *Background:* Enhancing the effectiveness of the community and aged care workforce to prevent malnutrition and functional decline is important in reducing hospital and aged care facility demand. *Objective:* To investigate the impact of nutrition-related interventions delivered to or by informal carers and non-clinical community care workers on malnutrition-related health outcomes of community-dwelling older adults (≥ 65 years). *Methods:* Intervention studies were searched for using six electronic databases for English-language publications from January 1980 to 30 May 2012. *Results:* Nine studies were eligible for inclusion. The strength and quality of the evidence was moderate (six studies with level II intervention evidence, five with positive quality). Types of interventions used were highly varied. The majority of interventions were delivered to informal carers (6 studies), with three of these studies also involving older adult care recipients. Five interventions were targeted at identifying, preventing and/or treating malnutrition specifically (two positive quality, three neutral quality, $n=2368$). As a result of these interventions, nutritional status improved or stabilized (two positive quality, two neutral quality, $n=2333$). No study reported an improvement in functional status but two successfully prevented further decline in their participants (two neutral quality, $n=1097$). *Conclusion:* Interventions targeted at identifying, preventing and/or treating malnutrition were able to improve or prevent decline in nutritional and functional status, without increasing informal carer burden. The findings of this review support the involvement of non-clinical community care workers and informal carers as part of the nutritional care team for community-dwelling older adults.

Key words: Aged, caregiver, community, malnutrition, nutrition.

Introduction

The World Health Organization has said "...population ageing is one of humanity's greatest triumphs" (1) and while this is true, it also presents some of the greatest challenges to the health and aged care sectors. As populations continue to age, enhancing the effectiveness of the community and aged care workforce to improve overall health of older adults will be key in reducing hospital and aged care facility demand, a priority target of current health service research and policy (2-4).

Malnutrition (undernutrition) occurs when food and nutrient intake is unable to meet nutrient requirements over time leading to a disruption of homeostasis in body weight, body composition and physical function (5). The consequences of malnutrition are significant, including increased risk of pressure ulcers, impaired wound healing, falls, hospitalizations, earlier institutionalization and mortality (6-13). In Australia, the prevalence of malnutrition in the community is estimated to be 10-30% (14), however chronic disease states and the physiological and psychosocial changes that occur in ageing place older adults (≥ 65 y (15)) at higher nutritional risk (14). In a multinational comparison ($n=12$ countries; $n=964$ community-dwelling participants) using retrospective pooled data of studies which utilized the MNA (Mini Nutritional

Assessment tool), 32% of older adults were classified as at risk of malnutrition, and 6% were classified as malnourished (9.5% males, 5.3% females) (16). Despite the significant physical, social and economic consequences of malnutrition and significant prevalence in the older population, there is strong evidence to show malnutrition is under-recognized and under-diagnosed in the community setting. Until this is addressed, no clear recommendations can be made regarding frequency of malnutrition screening nor treatment protocols (14, 17).

An ageing population increases the pressure of resourcing adequately trained health professionals in the aged and health care sectors (18). In response to these workforce pressures, the aged care sector has been moving towards a more streamlined, lower cost workforce by utilizing non-clinical staff, which currently make up the majority of the workforce (19). Due to these changes in the aged care workforce, non-clinical community care workers and informal carers may have the most important role in the provision of services to prevent malnutrition in community-dwelling older adults. However, there is limited research in this area and it is unclear to what extent these caregivers are able to affect malnutrition-related outcomes in community-dwelling older adults.

ARE INFORMAL CARERS AND COMMUNITY CARE WORKERS EFFECTIVE IN MANAGING MALNUTRITION?

Aim

To investigate the impact of nutritional interventions delivered to or by informal carers and non-clinical community care workers on malnutrition-related health outcomes of community-dwelling older adults.

Methods

A systematic literature review of current evidence was conducted. The review methodology was designed in reference to the Cochrane Handbook of Systematic Reviews of Interventions (20).

Search strategy

Intervention studies were searched using the electronic databases CENTRAL, CINAHL (via Ebscohost), EMBASE, Health Source: Nursing/Academic Edition, PubMed and Web of Science for English-language publications from 1980 to 30 May 2012. The search strategy was tailored utilizing each databases' controlled vocabulary or subject terms (Appendix). Briefly, the MeSH Terms aged, caregivers, homemaker services, home health aides, community networks, inservice training, education, nonprofessional, protein energy malnutrition, malnutrition, and nutritional status were used to search PubMed and CENTRAL in various combinations. CENTRAL was also searched using the MeSH terms as keywords. The search terms for CINAHL (via Ebscohost), Health Source: Nursing/Academic Edition (via Ebscohost), EMBASE and Web of Science were those that were the equivalent of the MeSH term. Where a controlled vocabulary did not have a suitable subject term the search term was entered as a keyword.

Interventions were considered which were delivered to 1) informal carers: adults ≥ 18 y who provide care for community-dwelling older adults, ≥ 65 y (15), and have no professional caregiving education or training, or 2) Non-clinical community care workers: paid workers who provide in-home care to community-dwelling older adults and have no health-related professional background or education. Interventions were considered if they were delivered in an in-home, community or outpatient setting. Studies which addressed samples of adults < 65 y were included if the mean age of the study population was ≥ 65 y. Studies in which the community-dwelling older adult receives intervention were included if their informal carer or community carer was involved.

Exclusions

Studies were excluded if participants received enteral tube feeding, parenteral nutrition, hemodialysis, peritoneal dialysis or had diabetes, cardiovascular disease or cancer. Studies that delivered an intervention without any nutritional component, did not involve informal or non-clinical community care workers or did not target the intervention to improving outcomes in community-dwelling older adult care recipients were also excluded. Abstract, conference papers and

unpublished studies were not considered.

Selection of studies

A two-step screening process was employed. In step 1, one author scanned the titles and abstracts of studies identified by the search for their eligibility. Full text articles that were identified as eligible or unclear were retrieved. At step 2, full-text articles were screened by one author for eligibility and included studies were checked by a second author.

Data extraction and synthesis

Data was extracted into standardized tables by a single author. A list of outcome measures meaningful to the review objective was developed in order to identify the relevant effects of interventions and highlight gaps in the current body of evidence. The list of outcomes was divided into primary outcomes (outcomes of foremost interest for analysis) and secondary outcomes (not primary concern but still relevant). The primary outcome measures in the care recipient were malnutrition, weight change, muscle strength, quality of life, functional status, institutionalization and hospitalization. Secondary outcome measures in the care recipient included body fat, muscle mass, nutritional intake, nutritional knowledge, biomarkers of nutritional status, complications/comorbidities of malnutrition (edema, pressure ulcers, infections, delayed wound healing), subjective wellbeing and healthcare costs/utilization. Secondary outcome measures in the informal carer included carer burden, mental health, quality of life, self-efficacy, subjective wellbeing and nutritional knowledge. Secondary outcomes measures of non-clinical community care workers included nutritional knowledge, food preparation skill competencies, care behavior and cost-effectiveness to organization. Results were reported as significant at the $P < 0.05$ level. Non-significant (NS) results were reported as such. As well as study design, participant characteristics and outcomes, the interventions were described. Control groups did not receive nutritional intervention or care unless specified otherwise.

Review of study quality

The strength of studies was determined using the National Health and Medical Research Council (NHMRC) levels of evidence according to type of research question (21). The NHMRC levels of evidence provide a guide to the strength of evidence addressing clinical questions based on a hierarchy of study design, and are graded I (strongest) to IV (weakest) (21). The quality of studies was assessed using the Academy of Nutrition and Dietetics' Quality Criteria Checklists for primary research or review article, where appropriate, and designated with a positive (+, strong quality), neutral (\emptyset , neither strong nor weak quality) or negative (-, weak quality) assessment (22). Review of strength and quality of studies was conducted by one author and checked by a second author. Where the authors did not agree, the study was reviewed by a third author. Results of studies identified as having a negative study quality were

excluded from data synthesis.

Results

The search identified a total of 1962 citations, of which 195 full-texts were retrieved at step 1 (Figure 1). Using an inclusion/exclusion form, 11 studies were identified as eligible for review (Table 1). Table 2 describes the nutrition interventions and outcomes of the included studies. There were seven studies which addressed primary outcomes, four of which also measured secondary outcomes (23-26). Two studies solely addressed secondary outcomes (27, 28), and two addressed no outcomes (29, 30). Overall the strength of the evidence was moderate with six of the 11 studies being randomized controlled trials (RCTs), five with positive quality.

Four studies were found to have neutral quality (26, 29, 31, 32) and two were found to have negative quality (28, 30), which were excluded from analysis. There were no conflicts in assessment of study strength and quality between primary and secondary investigators.

Interventions delivered to informal carers or non-clinical care workers of community-dwelling older adults

The majority of interventions were delivered to informal carers (n=6), with three of these studies also including older adult care recipients. Three studies were identified which involved non-clinical community care workers (29, 31, 32), however all had neutral quality and the only study which provides level II intervention evidence did not measure primary

Table 1
Characteristics of identified studies

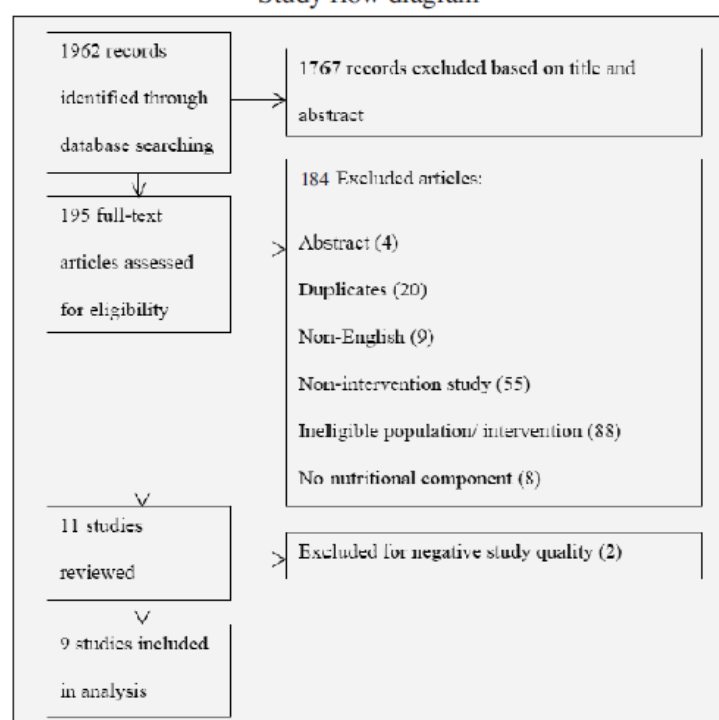
Citation	Setting	Study Design	Study Sample	Attrition	NHMRCL Level (21)	AND Quality (22)
<i>Studies addressing primary with or without secondary outcomes</i>						
Kurz, et. al. 2010 (23)	Austria, Switzerland, Germany	RCT	- Informal carers of older adults with dementia - n=292 patient-carer dyads - Care recipient age: μ 76y - Carer age: μ 62y	Unclear	II, Intervention evidence	+
Lauque, et. al. 2004 (24)	France	RCT	- Older adults with Alzheimer's disease - n=91 - Care recipient age: μ 79y	12%	II, Intervention evidence	+
Masud Rana, et. al. 2009 (33)	Bangladesh	Cluster RCT. Cluster units: villages	- Older adults and their families - n=1031 older adults - Care recipient age: \geq 60y	18.6%	II, Intervention evidence	+
Salva, et. al. 2011 (25)	Spain	Cluster RCT. Cluster units: medical facility	- Physicians, older adult with dementia and their carer (informal or professional) - n=946 patient-carer dyads - Care recipient age μ 79.0y	31%	II, Intervention evidence	+
Riviere, et. al. 2001 (26)	France	Non-randomized experimental trial: Controlled before-and-after study	- Informal carers of older adults with Alzheimer's disease - n=151 patient-carer dyads - Care recipient age: μ 75.4 – 77.3y - Carer age: μ 60.5 – 64.8y	5%	III-2, Intervention evidence	Ø
Laforest, et. al. 2007 (31)	Canada	Pilot case-series: post-test	- Older adult nutrition volunteers and older adult care recipients - n=35 care recipients, n=15 volunteers, n=12 case-managers - Care recipient age: μ 82y - Carer age: \geq 65y	17% (care recipients)	IV, Intervention evidence	Ø
Leggo, et. al. 2008 (32)	Australia	Case series: pre-test/post-test	- HACC eligible older adults and HACC providers - n=1145 screened - Care recipient age: μ 76.5y	40% receiving intervention (n=57)	IV, Intervention evidence	Ø
<i>Studies addressing secondary outcomes only</i>						
Toseland, et. al. 2004 (27)	USA	RCT	- Informal carers (spouses) of frail older adults - n=105 patient-carer dyads - Care recipient age: μ 72y - Carer age: μ 68 – 69y	Unclear	II, Intervention evidence	+
Glanz & Scarf, 1985 (28)	USA	N/A	N/A	N/A	IV, Intervention evidence	–
<i>Studies with no primary or secondary outcomes</i>						
Hyland, et. al. 2006 (29)	UK	Cluster RCT	- Older adults and peer community nutrition assistants - n=97 - Care recipient age: μ 76y - Carer age: $>$ 60y	Unclear	II, Intervention evidence	Ø
Paul, et. al. 2000 (30)	USA	N/A	N/A	N/A	IV, Intervention evidence	–

AND, Academy of Nutrition and Dietetics; HACC, Home and Community Care; NHMRC, National Health and Medical Research Council; RCT, Randomized controlled trial; y, year.

ARE INFORMAL CARERS AND COMMUNITY CARE WORKERS EFFECTIVE IN MANAGING MALNUTRITION?

or secondary outcomes of interest. In addition, the study by Salva et al. (25) reported that 6-9% of carers in the study were 'paid carers', however the methods and results were not disaggregated by type of caregiver. The study by Lauque et al. (24) provided intervention in the form of oral nutrition supplementation only to older adults and did not involve carers or care workers. However, in this study the control group's usual care included informal carer education and this resulted in significant improvements. For this reason results of only the control group were considered. There were five studies identified which provided intervention to the general older adult population (27, 29, 31-33), and four targeted at older adults with dementia (23-26).

Figure 1
Study flow diagram



Of the seven studies which addressed primary outcomes associated with malnutrition in older adult care recipients, five were targeted at identifying, preventing and/or treating malnutrition (24-26, 31, 32). The RCT by Lauque et al. (24) aimed to prevent and treat malnutrition in older adults with Alzheimer's disease. Although this resulted in significant improvements in malnutrition (using the MNA score), unfortunately the education provided to the informal carers was not described. Salva et al. (25) delivered the NutriAlz program to informal carers of older adults at nutritional risk. However, the intervention was also provided to physicians who enhanced the care of the older adults, and it is therefore unclear to what extent the results reflect the intervention provided to informal carers. In the study by Riviere et al. (26) health professionals, including a dietitian, provided group education to informal carers of older adults with Alzheimer's disease to prevent weight loss in this group. The intervention was

multidimensional as it addressed appropriate food choices as well as skill building and patient monitoring. The study by Laforest et al. (31) was the only study in which non-clinical community care workers were trained to screen and provide education to older adults. The study conducted by Leggo et al. (32) also involved non-clinical community care workers, however, only in malnutrition screening. Participants identified as being at risk of malnutrition were referred to a clinical dietitian for treatment.

In two of the four studies in which the intervention did not focus on malnutrition, nutritional components were only minor parts of the intervention and were not described (23, 27). Of the remaining two studies, Hyland et al. (29) delivered a comprehensive and feasible program to improve the nutritional health of older adults however the study only reported qualitative results relating to the experiences of the non-clinical community care workers. Hyland et al. (29) refer to a second paper which measured outcomes of interest, including non-clinical community care worker nutrition knowledge; however this was unavailable for review. The study by Masud Rana et al. (33) aimed to improve health-related quality of life in old age however focused on bone and joint-related illness and provided education not consistent with malnutrition prevention or treatment, for example promotion of fat free foods.

Outcomes in older adult care recipients

Nutritional and functional status were the most commonly reported primary outcomes. Three of four studies that measured nutritional status reported an improvement (24, 25, 32) and Riviere et al. reported no change (26) (two positive quality, two neutral quality, n=2333 participants in total). Where no change was seen in the intervention group of the study by Riviere et al. (26), decline was seen in the control group. No study reported an improvement in functional status, however, two of the three studies which measured this outcome prevented decline in their participants (25, 26) (two neutral quality, n=1097 participants in total). These two studies were focused on the prevention and treatment of malnutrition in participants with dementia (25, 26). Although Lauque et al. (24) reported a significant decline in functional status in their control group (the group of interest which utilized informal carers), a significant decline was also seen in their intervention group, however, to a lesser extent (-0.60±1.24 vs -0.50±1.22).

Where care recipient quality of life (one positive quality study, n=1031 participants in total) and energy and protein intake (one positive quality study, n=91 participants) were measured, improvements in results were found (24, 33). In the studies which reported no change in hospitalization, healthcare utilization and institutionalization incidence (23, 24), it is important to note that these study populations were high risk (dementia) and it may be beyond the capacity of the interventions chosen to affect these measures. No studies were identified which reported on the primary outcome of muscle strength or secondary outcomes of body fat and subjective wellbeing in older adult care recipients.

Table 2
Intervention characteristics and outcomes of identified studies

Citation	Intervention Delivery	Nutritional Intervention	Outcomes & Results
<i>Studies addressing primary with or without secondary outcomes</i>			
Kurz, et. al. 2010 (23)	- Point-of-contact: seven bi-weekly 90min group sessions and six bi-monthly refresher meetings (15m total intervention duration)* - Delivered by: specially trained psychologists or social workers - Delivered to: informal carers	- Aim of intervention: to educate informal carers about Alzheimer's Disease - Content: designed by German Alzheimer's Association. Module 4 (of 7) included nutrition as a problem solving example (not described) *content also deliverable via CD-ROM	- Informal carer quality of life: SF-36 improved only in the emotional role functions subscale (μ change 5.3 ± 48.5) - No significant results found in care recipient institutionalization (incidence of nursing home admissions), care recipient healthcare utilization (RUD-light), or informal carer mental health (MADRS)
Lauque, et. al. 2004 (24)	- Point-of-contact: geriatric wards and community day care centers - Delivered by: dietitian - Delivered to: older adult	- Aim of intervention: to prevent and treat malnutrition - Content: IG received oral supplementation of 300 – 500kcal/d for 3m. The CG received usual care which involved education of the informal caregiver (not described)	Results of CG: - Care recipient malnutrition risk: MNA score improved (μ increase of 2.46 ± 4.21) - Care recipient functional status: Katz ADL-index declined (μ change -0.60 ± 1.24) - Care recipient nutritional intake: 24h recall kcal/kg improved (μ change 2.93 ± 8.82), grams protein/kg improved (μ change 0.19 ± 0.48) - No significant results found in care recipient weight change, care recipient hospitalizations, care recipient functional status (eating behavior scale), care recipient complications of malnutrition (pressure ulcers, fractures), care recipient biomarkers (serum albumin, serum C-reactive protein) or care recipient muscle mass (fat free mass, DEXA)
Masud Rana, et. al. 2009 (33)	- Point-of-contact: workshops at offices, weekly counseling, small group and self-help meetings as well as community social marketing - Delivered by: physician and stakeholders - Delivered to: older adult care recipient and their informal carers	- Aim of intervention: to enhance health-related quality of life in old age - Content: health education focusing on health care management including bone and joint-related illness and other illness. Included physical activity, advice on food safety and healthy eating (fruit, vegetables, fat-free foods). Community social marketing included posters, leaflets, theatre, video documentary and celebrating International Day of Older Persons	- Care recipient quality of life: HRQoL significantly improved in compliant intervention group (μ change 0.6; less likely improvement in non-compliant group OR=0.52, 95% CI: 0.32, 0.82; less likely improvement in control group OR=0.44, 95% CI: 0.32, 0.59)
Salva, et. al. 2011 (25)	- Point-of-contact: physicians' rooms, group education, mail. - Delivered by: dietitian - Delivered to: physicians, older adult care recipients and their informal carers	- Aim of intervention: to improve the functional and nutritional status of patients with dementia living at home - Content: NutriAlz Program delivered to physicians and carers included 1) booklet on Alzheimer's disease, booklet on nutrition, available services and aids, booklet on physical activity, hotline access, program newsletter, 2) family and carers to attend presentations (n4) by dietitian, 3) support in weight monitoring, 4) voluntary register for carers for further information, 5) action protocols and decision trees related to malnutrition for professionals *6-9% of carers were 'paid', unclear if clinical or non-clinical	- Care recipient malnutrition: MNA improved in IG (μ change 0.46, 95% CI: 0.09, 0.83) and declined in CG (μ change -0.66 , 95% CI: -0.8 , -0.21) - Care recipient healthcare utilization and costs: RUD results not reported due to very low use - No significant results found in care recipient weight change, care recipient functional status (IADL) or informal carer burden (Zarit scale)
Riviere, et. al. 2001 (26)	- Point-of-contact: group education, nine 1h sessions over 12m - Delivered by: dietitian or other health professional - Delivered to: informal carers	- Aim of intervention: to prevent weight loss in patients with Alzheimer's disease - Content: the IG intervention focused on enriching food and how to combat eating behavior disorders but also included: 1) consequences of weight loss, skill building, weight monitoring, 2) coping with caregiver stress, 3) how to use MNA, 4) nutrition and food recommendations for balanced meals, 5) increasing protein and energy, 6) practical dietetics, 7) follow-up. The CG was offered advice provided in normal follow-up.	- Care recipient malnutrition: MNA no change in IG but decreased in CG (μ change -0.1 ± 3.4) - Care recipient weight change: weight increased in IG (μ change 0.7 ± 3.6 kg) but decreased in CG (μ change -0.7 ± 5.4 kg)* - Informal carer nutrition knowledge: Nutrition knowledge questionnaire increased significantly (μ change 1.7 ± 5.9) - No significant results found in care recipient functional status (ADL, IADL) or informal carer burden (Zarit scale) * After adjusting for baseline differences the weight change was not significant - Care recipient nutrition risk: ENS* *Only reliability of tool reported in results
Laforest, et. al. 2007 (31)	- Point-of-contact: in older adult's home, one pre-visit and three home visits - Delivered by: dietitian trained older adult non-clinical care workers (via two 3h group-training sessions) - Delivered to: older adult care recipients	- Aim of intervention: identify older adults at nutritional risk and intervene - Content: 1) screening (Elderly Nutrition Screening tool), 2) nutrition education using pamphlet and Canada's Guide to Healthy Eating, 3) development of intervention plan based on screening result, included Meals-on-Wheels, dietitian review, assistance with feeding, etc. Plan approved by dietitian, client and case-manager before implementation, 4) follow-up/review of plan	
Leggo, et. al. 2008 (32)	- Point-of-contact: in older adult's home - Delivered by: dietitian trained non-clinical community care workers (screening by project officers, allied health staff, community care coordinators) and dietitian (intervention) - Delivered to: older adult care recipients	- Aim of intervention: to identify and treat malnourished clients - Content: individualized nutrition counseling with use of individualized care plan, standard guidelines for advising high energy high protein diets, μ visits 4.2 (range 2 – 10) over a median of 6m from first to last visit	- Care recipient malnutrition: MST (15% at risk of malnutrition), PG-SGA (5% malnourished, 82% improved score following intervention)
<i>Studies addressing secondary outcomes only</i>			
Toseland, et. al. 2004 (27)	- Point-of-contact: eight 2h weekly group education sessions followed by ten monthly sessions at a staff model health maintenance organization - Delivered by: social worker - Delivered to: informal carers	- Aim of intervention: to support and education spousal caregivers of frail older adults - Content: emotion and problem focused including 1) coping strategies, 2) education on support services and health, 3) support. The fifth monthly meeting focused on nutrition and diet (not described) for both carer and care recipient	- Informal carer mental health: GHQ severe depression scale decreased (C _x T ₂ = 4.55), PPI increased in the effectiveness of scale only (C _x T ₁ = 9.38) - No significant results found in informal carer burden (MBBS), informal carer mental health (other GHQ components), mental component summary of SF-36 or informal carer perceived health status (physical component

ARE INFORMAL CARERS AND COMMUNITY CARE WORKERS EFFECTIVE IN MANAGING MALNUTRITION?

Glanz & Scarf, 1985 (28)	N/A	N/A	summary of SF-36) N/A
<i>Studies with no primary or secondary outcomes</i>			
Hyland, et al. 2006 (29)	- Point-of-contact: 20 weekly 2h group meeting at a sheltered housing complex - Delivered by: Non-clinical community care workers - Delivered to: Older adult care recipients	- Aim of intervention: to provide nutrition health education - Content: home economist and dietitian developed a food club program which focused on practical food preparation and healthy eating for older adults	N/A
Paul, et al. 2000 (30)	N/A	N/A	N/A

ADL, activities of daily living; CG, control group; CxT1/CxT2, condition x time interaction term; DEXA, dual-energy x-ray absorptiometry; GHQ, general health questionnaire; h, hour; HRQoL, health-related quality of life; IADL, Instrumental Activity of Daily Living; IG, intervention group; m, month; MADRS, Montgomer-Asberg Depression Rating Scale; min, minute; MBBS, Montgomery-Borgatta burden scale; MNA, Mini-Nutritional Assessment; PPI, pressing problems index; RUD-light, Resource Utilization in Dementia, short form; SF-36, Short Form Health Survey.

Outcomes in informal and non-clinical community care workers

No studies were identified which addressed secondary outcomes of interest in non-clinical community care workers. Four studies were identified which measured secondary outcomes in informal carers (23, 25-27), of which carer burden (n=3) followed by mental health (n=2) were the most frequently measured. In studies which addressed malnutrition, no significant change in carer burden was found (25, 26) (one positive quality, one neutral quality, n=1097 participants in total). Though the intervention delivered by Kurz et al. (23) did not lead to change in informal carer mental health, quality of life significantly improved (positive quality, n=292 participants). The intervention delivered by Toseland et al. (27) improved the mental health of informal carers with no change in carer burden. No studies were found which reported a decline in any outcome in informal carers.

Discussion

The goals of managing malnutrition in an older population include prevention of decline as well as treatment of disease (14). Therefore it must be recognized that for outcome measures concerning malnutrition in older adults, such as nutritional status, functional status, quality of life and weight change, that a non-significant result, when timing of data collection is appropriate, indicates a prevention of decline or disease. Indeed, two reviews of protein and energy supplementation in older adults at risk of malnutrition reported similar findings as the current review, with the majority of studies showing no change in functional status or quality of life of the participants (34, 35). Regarding economic outcomes, results published subsequently to the included paper (27), Toseland et al. (36) reported that the intervention delivered to informal carers resulted in a total health care cost saving of \$1,529.89 per caregiver and \$5,760.00 per care recipient compared with usual care; these cost savings were mostly driven by reductions in outpatient costs.

In this respect, interventions involving informal carers and non-clinical community care workers are an effective method to address malnutrition in the older adult community, without increasing the burden of care or cost of management. It is unfortunate that the only study identified which involved role

redesign for non-clinical community care workers did not report on the older adult care recipients' response to intervention (31).

In practice, the involvement of non-clinical community care workers and informal carers as part of the nutritional care team for community-dwelling older adults may improve nutritional status and prevent decline in functional status and quality of life. However, consideration should be given to the older adult disease state, community setting, resources available, multidisciplinary health professional involvement and the degree of caregiver training and supervision in nutritional management of older adults.

There is a need to explore the extent to which informal carers' and non-clinical community care workers' roles can affect malnutrition in the general older adult population as opposed to certain high risk groups only. It is clear from the limited studies presented here that non-clinical community care workers can be used to identify malnutrition but it is less clear how they can be best used to provide basic interventions and the economic impact this might have in terms of health care utilization and costs. Researchers should report interventions fully and use validated outcome measures including a confirmed diagnosis of malnutrition, functional status and quality of life, while also reporting the effects of interventions on carers' wellbeing.

Conclusion

The inclusion of non-clinical community care workers and informal carers is a promising area for identifying, preventing and treating malnutrition in community-dwelling older adults in order to increase the efficacy of the health and aged care workforce. Interventions targeted at identifying, preventing and/or treating malnutrition were able to improve or prevent decline in nutritional and functional status, without increasing informal carer burden.

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Appendix

Search strategy for the electronic databases CENTRAL, CINAHL (via Ebscohost), EMBASE, Health Source: Nursing/Academic Edition, PubMed and Web of Science. PubMed was searched using the following MeSH Term combinations:

- 1) Aged
- 2) Caregivers
- 3) Homemaker services
- 4) Home Health Aides
- 5) Community Networks
- 6) Inservice training
- 7) Education, nonprofessional
- 8) Protein energy malnutrition
- 9) Malnutrition
- 10) Nutritional status
- 11) Nutrition Assessment

- 1) 1 AND (2 OR 3 OR 4 OR 5) AND (6 OR 7)
- 2) (1 OR 2 OR 3 OR 4 OR 5) AND (8 OR 9 OR 10 OR 11)

In CENTRAL, MeSH Terms were searched in the following combinations:

- 1) Aged
- 2) Caregivers
- 3) Homemaker services
- 4) Home Health Aides
- 5) Community Networks
- 6) Inservice training
- 7) Education, nonprofessional
- 8) Protein energy malnutrition/prevention and control
- 9) Protein energy malnutrition/diet therapy
- 10) Malnutrition/prevention and control
- 11) Malnutrition/diet therapy
- 12) Nutritional status
- 13) Nutrition Assessment
- 14) Malnutrition/diagnosis
- 15) Protein energy malnutrition/diagnosis

- 1) 1 AND 7
- 2) (2 OR 3 OR 4 OR 5) AND (6 OR 7)
- 3) (1 OR 2 OR 3 OR 4 OR 5 OR 6) AND (8 OR 9 OR 10 OR 11 OR 12)
- 4) (1 OR 2 OR 3 OR 4 OR 5 OR 6) AND (13 OR 14 OR 15)

CENTRAL was also searched using keywords in the title, abstract and keywords:

1. (Elderly OR Aged OR Carer OR Caregiver OR Community Care OR Home Health Care) AND (Education OR Training) AND (Nutrition OR Malnutrition)

CINAHL (via Ebscohost) was searched using the following CINAHL Headings:

1. (Aged [exp] OR Caregiver OR Home Health Care) AND (Patient Education OR Education OR Health Education OR Training [as keyword - subject]) AND (Malnutrition OR Protein-Energy Malnutrition OR Nutrition [as keyword - subject]).

Health Source: Nursing/Academic Edition (via Ebscohost) was searched using the following Health Source Subjects:

1. (Older People [exp] OR Caregivers [exp] OR Community health aides) AND (Adult education OR Aging education OR Consumer education OR Educational intervention OR Educational programs OR General education OR Health education OR Nonformal education OR Older people – education OR Veterans – education OR Training) AND (Malnutrition [exp] OR Nutrition disorders in old age OR Nutrition [as keyword - abstract/title])

EMBASE was searched using Emtree terms:

1. Aged [exp] AND (Caregiver OR Community care [exp] OR Home care [exp]) AND (Education [exp] OR Staff training) AND (Malnutrition [exp]/Diagnosis OR Malnutrition [exp]/Disease management OR Malnutrition [exp]/Prevention OR Malnutrition [exp]/Side effect OR Malnutrition [exp]/Therapy OR Diet OR Diet therapy OR Feeding behaviour OR Food intake OR Geriatric nutrition OR Meal OR Nutrient management OR Nutrition education OR Nutritional assessment OR Nutritional counselling OR Nutritional status)

Web of Science, as also searched for the following keywords in topic or title:

1. (Aged OR Elderly) AND (Caregiver OR Carer OR Community care OR Home care OR Home aides) AND (Education OR Training) AND (Nutrition OR Malnutrition)

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3.2.3 Statement of contribution to publication by authors

Skye Marshall carried out the literature review, data extraction and analysis, interpretation of data, drafting and revision of the manuscript; Judith Bauer and Elizabeth Isenring reviewed study quality and strength; and Sandra Capra, Judith Bauer and Elizabeth Isenring provided supervision, guidance and revision of the manuscript.

3.2.4 Conclusion and implications of findings

The aim of this systematic review was to investigate the impact of nutrition-related interventions delivered to or by informal carers and non-clinical community care workers on malnutrition-related health outcomes of community-dwelling older adults (≥ 65 years).

In regards to this aim, the review found that the role of informal caregivers in the management of malnutrition in community dwelling older adults is an emerging area of research. Preliminary results indicate that the inclusion of informal caregivers is a promising area for identifying, preventing and treating malnutrition in community-dwelling older adults in order to improve patient outcomes without increasing the burden of care.

Future intervention studies would benefit from qualitative exploration of the roles, experiences and support needs of informal caregivers of malnourished older adults, to help ensure interventions will be patient-centred and informal caregiver-centred (chapter 7). This review found there is a general need for well-designed and adequately powered trials before recommendations can be made for practice. Specifically, further evidence is needed to address caregiver's roles in affecting malnutrition risk in the general older adult population as opposed to certain high risk groups only.

The difficulty in identifying malnourished older adults in the community remains a significant barrier when considering any method of managing malnutrition in community-dwelling older adults, as there is no ideal way to screen the millions of older Australians living at home for malnutrition (2007b). However, it is well established that older adults have a high risk of hospitalisation if they are malnourished (Krumholz, 2013; Mudge et al., 2011; Sullivan, 1992). Therefore, rather than providing short-term treatment for malnutrition during health care admissions, hospitalisation presents an opportunity to engage with the informal caregivers and continue support of this chronic condition in the longer term at home. Intervention studies engaging the informal caregiver during in-patient treatment of malnutrition in older adults would be of high interest and contribute significantly to future health care policy.

The role of non-clinical community care workers in managing malnutrition in community dwelling older adults is largely unexplored. This review found one study to suggest that these care workers may have a role in nutrition screening, which may help to utilise the health and aged care workforce more effectively. If proper pathways and resources are set in place, nutrition screening by non-clinical care workers may improve patient outcomes across communities. However, exploratory studies are also required investigate the role that non-clinical home-based and community care workers may have in providing basic nutrition interventions, and the economic impact this may have in terms of health care utilisation and costs. Methods of quality control will need to be determined, as will the acceptability of the scheme by community care organisations.

Finally, researchers should report interventions fully so that future studies may build upon the current emerging research. Researchers should use validated outcome measures including a confirmed diagnosis of malnutrition by a dietitian or trained health professional to increase the quality of evidence.

CHAPTER 4

NUTRITIONAL RISK IN OLDER ADULTS FOLLOWING DISCHARGE FROM REHABILITATION TO THE COMMUNITY

4.1 Preliminary exploratory literature review

A preliminary exploratory literature review was conducted to identify current interest and evidence in older adult (≥ 65 years) malnutrition prevalence and malnutrition-related interventions in patients receiving rehabilitation and/or transitional care with a focus on post-discharge outcomes.

4.1.1 Search strategy

Published English-language literature from 1990 to February 2013 from the health-related electronic database PubMed was conducted. The search was conducted using the following MeSH terms: (*Aged* OR *Aged, 80 and over*) AND (*Protein-Energy Malnutrition* OR *Malnutrition* OR *Nutritional Status* OR *Nutrition Assessment*) AND *Rehabilitation*.

4.1.2 Selection strategy and procedures

Inclusion criteria: studies describing the nutrition-related health status of older adult (≥ 65 years) rehabilitation or transitional care patients, as inpatients or post-discharge.

Exclusion criteria: patients admitted to acute care, nursing homes, long-term care or day centres where they are not undergoing a rehabilitation program; community-dwelling older adults not sampled in a rehabilitation or transitional care centre; patients receiving cardiac rehabilitation; patients receiving haemodialysis; research focusing on diabetes management.

Titles and abstracts were assessed for eligibility. Full-text articles were retrieved and further assessed for eligibility. An evidence table was used to identify characteristics of the studies.

4.1.3 Quality assessment

Strength of evidence was assessed using the NHMRC levels of evidence according to type of research question (appendix I) (Coleman et al., 2005).

Table 4.1: Evidence summary of malnutrition-related health indicators in rehabilitation and transitional care in-patients pre and/or post discharge

Citation	NHMRC Level	Study Design	Sample	Intervention
Studies of inpatients exclusively				
(Charlton et al., 2010)	III-3 – Prognosis evidence	Retrospective cohort study	$\geq 65y$, $\mu=80.6y (\pm 27.7)$ $n=2076$ Admitted to two rehabilitation hospitals in NSW, Australia Data collection: 2003 - 2008	N/A
(Chevalier et al., 2008)	IV – Aetiology evidence	Cross-sectional study	$\mu=78.1-85.9y$ $n=182$ Participated in ambulatory rehabilitation programs at two general hospitals in Quebec, Canada Data collection: not specified	N/A
(Foss et al., 2007)	II- Aetiology evidence	Prospective cohort study	$\geq 65y$, $\mu=83y$ $n=262$ Participated in a rehabilitation program for hip-fracture patients in a general hospital in Denmark Data collected: 2003 - 2004	N/A
(Kaur et al., 2008)	IV- Aetiology evidence	Cross-sectional study	$\mu=72y$ $n=229$ Participated in an ambulatory rehabilitation program at a general hospital in SA, Australia Data collected: 2005 - 2006	N/A

Citation	NHMRC Level	Study Design	Sample	Intervention
(Soderhamn et al., 2007)	N/A – frequency/rate hypothesis	Cross-sectional study	≥65y, $\mu=77.0y$ ($\pm 6.1y$) n=147 Admitted to a rehabilitation unit in Sweden Data collected: 2002 - 2005	N/A
(Westergren et al., 2001)	N/A – poor study design for prognosis evidence	Cross-sectional study	$\mu=78.6y$ n=162 Admitted to rehabilitation unit in a general hospital in Sweden Data collected: 1996 - 1997	N/A
(Westergren et al., 2002)	N/A – poor study design for prognosis evidence	Cross-sectional study	≥65y, $\mu=81.0y$ n=520 Admitted to several rehabilitation wards in Sweden Data collected: 1996 - 1998	N/A
Studies with post-discharge follow-up				
(McMurtry & Rosenthal, 1995)	II – Aetiology evidence	Prospective cohort study	$\mu=73y$ ($\pm 11.6y$) n=83 Admitted to a geriatric rehabilitation unit in Virginia, USA 2y follow-up post-discharge Data collected: not specified	N/A
(Neumann et al., 2005)	II – Prognosis evidence	Prospective cohort study	≥65y, $\mu=81y$ ($\pm 6y$) n=133 Admitted to a rehabilitation unit in SA, Australia 90d follow-up from baseline Data collected: 2003	N/A

Citation	NHMRC Level	Study Design	Sample	Intervention
(Nicosia et al., 2012)	II – Prognosis evidence	Prospective cohort study	≥ 65 y, $\mu=79$ -81y n=243 Admitted to a rehabilitation unit in Italy 2y follow up from baseline Data collected: 2007 - 2008	N/A
(Sullivan et al., 1991)	II- Aetiology evidence	Prospective cohort study	$\mu=78$ y (± 9 y) n=109 Admitted to a rehabilitation unit Arkansas, USA 1y follow-up post discharge Data collected: 1987 - 1988	N/A
(Sullivan et al., 1995)	II- Aetiology evidence	Prospective cohort study	$\mu=76$ y n=322 Admitted to a rehabilitation unit Arkansas, USA 1y follow-up post discharge Data collected: not specified	N/A

N/A, not available; NHMRC, National Health and Medical Research Council; NSW, New South Wales; SA, South Australia; USA, United States of America; y, year.

Table 4.2: Outcome measures of rehabilitation and transitional care in-patient and post-discharge studies

	MNA	MNA-SF	LOS	SNAQ	SGA	Weight	Weight change	Nutritional Status Score	BMI	FFM via bioimpedance	FM via bioimpedance	Handgrip strength	Gait speed	New mobility score	Serum albumin	Skin fold thickness	Body circumferences	Polypharmacy	MMSE	Oral energy intake	Oral protein intake	Mortality	Institutionalisation	Hospitalisation	Infection	SF-36	Modified Barthel Index	Katz Index	IADL	NUFFE	Eating difficulties	Pressure ulcers	
Studies of in-patients exclusively																																	
(Charlton et al., 2010)	x ^a	x	x			x			x																								
(Chevalier et al., 2008)	x					x			x	x		x	x		x	x	x	x	x														
(Foss et al., 2007)			x			x			x					x	x			x		x	x	x	x		x								
(Kaur et al., 2008)	x		x	x					x	x	x						x									x	x						
(Soderhamn et al., 2007)									x																						x		
(Westergren et al., 2002)					x				x									x										x			x	x	
(Westergren et al., 2001)					x				x																				x			x	
Studies with post-discharge follow-up																																	
(McMurtry & Rosenthal, 1995)			x					x	x						x				x			x	x		x								
(Neumann et al., 2005)	x	x							x															x			x						
(Nicosia et al., 2012)		x							x	x	x				x							x						x	x				

(Sullivan et al., 1991)					x		x		x						x	x	x		x								x				
(Sullivan et al., 1995)							x		x						x	x	x	x	x								x				

BMI, body mass index; FFM, fat free mass; FM; fat mass; IADL, instrumental activities of daily living; LOS, length of stay; MMSE, mini-mental state examination; MNA, Mini Nutritional Assessment; NUFFE, nutritional form for the elderly; SF, short form; SGA, subjective global assessment; SNAQ, Simplified Nutrition Appetite Questionnaire.

a outcome measure used in the study.

4.1.4 Results

Twenty-three of 592 citations located in the search were considered eligible based on title and abstract. Five texts were unable to be retrieved due to restricted access. Following full-text revision, 12 were identified as eligible for review (table 4.1). No intervention evidence was identified and all studies were observational (five cross-sectional, six prospective and one retrospective cohort studies). Overall the strength of the evidence was poor to moderate with two of five prognosis studies achieving level II evidence, and four of six studies with level II aetiology evidence. Two prognosis studies could not be designated a level as cross-sectional study design is not appropriate for the research hypothesis. There was one frequency/rate study. Five of the 12 studies included follow-up post-discharge. The strength of evidence was good in these studies, with all achieving level II evidence (two prognosis studies, three aetiology studies). Follow-up outcome assessments were all assessed at a single time-point, ranging from 90 days to 2 years. Of these five studies the following outcome measures were assessed post-discharge: physical function (n=1 study), quality of life (n=1 study) and mortality (n=4 studies).

The most common measure of nutrition status was the MNA (n=4 studies), followed by the SGA (n=3 studies) (table 4.2). The MNA-SF was also employed in two studies. Body mass index was the most common outcome measure, utilised in all 12 studies. Other anthropometric measures included body circumference (n=4 studies), fat free mass via bioimpedance (n=3 studies) and skinfold thickness (n=3 studies). Serum albumin is also of high interest as a nutrition status marker, reported in six studies.

Following BMI and serum albumin, mortality was the third most reported outcome (n=5 studies). Potential confounders or contributors to poor nutrition status were of some interest, as polypharmacy and cognition via the Mini-Mental State Examination (MMSE) was reported in four studies each. Physical function was of high interest, but outcome measurement tools varied, with the Katz Index the most utilised (n=5 studies). Quality of life was not reported in any study.

4.1.5 Discussion

There is limited research in terms of study strength regarding the nutritional risk of older adults admitted to rehabilitation units, and the change in malnutrition risk as they transition into the community was not explored despite being of high clinical relevance. Importantly, there were no intervention studies identified which aimed to improve the nutrition status

of older adults undergoing rehabilitation, or to assist in their transition to the community to prevent re-admission and mortality.

This brief-preliminary literature review warrants further systemic exploration regarding the prevalence and consequences of malnutrition in the older adult rehabilitation population with a focus on identifying post-discharge nutrition status and its consequences.

4.2 The consequences of malnutrition following discharge from rehabilitation to the community: A systematic review of current evidence in older adults

4.2.1 Introduction

As discussed in chapter 1, rehabilitation facilities play a vital role in supporting a healthy ageing Australia and are likely to increase in importance as the proportion of older adults increases. The findings of the systematic review undertaken in chapter 3 suggest intervention studies engaging the informal caregiver during in-patient treatment of malnutrition in older adults would be of high interest and contribute significantly to future health care policy. Although malnutrition prevalence is high in community and rehabilitation settings, the exploratory review presented in this chapter indicates relationship between the two settings has been little explored. Therefore, a systematic review was undertaken which aimed to determine the association between malnutrition in older adults admitted for rehabilitation and nutrition status, functional status, quality of life, institutionalisation, acute care admissions and mortality once discharged to the community.

4.2.2 Publications

Marshall, S., Bauer, J., Isenring, E. (2014) The consequences of malnutrition following discharge from rehabilitation to the community: A systematic review of current evidence in older adults. *Journal of Human Nutrition and Dietetics*, **27**: 133-141⁵. Published by John Wiley & Sons, Inc. DOI: 10.1111/jhn.12167. *Citations at the time of thesis submission: 19.*

This study has also been published and presented elsewhere:

- *Published abstract:* **Marshall S,** Bauer J, Isenring E. The consequences of malnutrition following discharge from rehabilitation to the community: A systematic review of current evidence in older adults [Abstract]. *Nutrition & Dietetics*. 2014;71(S1):5.

⁵ Page numbers of the featured publication correspond with the journal publication and not with this thesis.

- *Oral presentation:* **Skye Marshall**, Judith Bauer, Elizabeth Isenring. The consequences of malnutrition following discharge from rehabilitation to the community: A systematic review of current evidence in older adults. 31st DAA National Conference, Brisbane, 15 – 17th May 2014.

CLINICAL NUTRITION

The consequences of malnutrition following discharge from rehabilitation to the community: a systematic review of current evidence in older adults

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Keywords

aged, community, malnutrition, nutritional status, rehabilitation.

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from rehabilitation to the community: a
systematic review of current evidence in older
adults. *J Hum Nutr Diet.* **27**, 133–141
doi:10.1111/jhn.12167**Abstract**

Background: The prevalence of malnutrition in the rehabilitation setting is estimated to be 30–50%, with older adults at higher nutritional risk. Malnutrition also exists in the community setting, where 10–30% of adults are malnourished; however, the relationship between the two settings has been little explored. The present study aimed to determine the association between malnutrition in older adults admitted for rehabilitation and nutrition status, functional status, quality of life, institutionalisation, acute care admissions and mortality once discharged to the community.

Methods: Six electronic databases were searched for relevant publications (1990–2013) using controlled vocabulary. Longitudinal papers were included in which older adults (≥ 65 years) were admitted for rehabilitation if nutrition assessment was performed during admission with relevant outcomes measured following discharge to the community.

Results: Five observational studies were eligible for review which had similar populations. The five reviews comprised 1020 participants in total and, once discharged, follow-up ranged from immediate to 26 months. Malnutrition during rehabilitation was negatively associated with physical function and quality of life, and positively associated with risk of institutionalisation, hospitalisation and mortality. Although these studies were of high quality and strength, the overall contribution to the evidence is limited as a result of the small number of heterogenic studies. No intervention studies were identified.

Conclusions: Malnutrition in older adults admitted for rehabilitation has a negative effect on functional recovery and quality of life following discharge to the community. This review highlights an evidence gap along the continuum of care for malnourished older adults, where further observational and intervention research is needed following discharge from rehabilitation to the community.

Introduction

Malnutrition occurs when food and nutrient intake is unable to meet protein, energy and nutrient requirements over time, leading to a disruption of homeostasis in lean tissues, body weight and physical function (Kunert, 2005; Skipper, 2012). Malnutrition may be both a consequence

and a cause of disease (Watterson *et al.*, 2009). The physiological and psychosocial consequences of malnutrition are significant and diverse, and contribute to impaired recovery from injury and illness (Stratton *et al.*, 2003; NICE, 2006). This is significant in the rehabilitative setting, where malnutrition prevalence is estimated to be 30–50%, and is associated with an extended length of stay

(Finestone *et al.*, 1996; Watterson *et al.*, 2009; Charlton *et al.*, 2010; O'Leary *et al.*, 2011). The rehabilitation setting is defined as an in-patient service by a multidisciplinary team with the goal of reducing disability and improving task-orientated functional behaviour (Cameron *et al.*, 2008), such as a stroke or hip fracture rehabilitation centre or rehabilitation ward in a general hospital. A 2003 study by Olsson & Karlstrom (2003) found that 18 of 19 older women admitted for rehabilitation had inadequate oral protein and energy intake; however, all participants considered that they consumed sufficient food to meet their physiological need.

The chronic diseases and the physiological and psychosocial changes that occur in ageing place older adults ≥ 65 years (AIHW, 2010) at higher nutritional risk, both during health service admissions and in the community (Watterson *et al.*, 2009). It is estimated that 10–30% of adults in the community, comprising free-living populations with or without community services, are malnourished. (Watterson *et al.*, 2009). There is level I evidence to indicate that malnutrition is under-recognised and under-diagnosed both in rehabilitation and community settings (Watterson *et al.*, 2009); however, the relationship between the two has been little explored.

As a result of the variable temporal and physiological nature of malnutrition, there is no single measure sufficiently accurate or reliable as a sole method of diagnosis for malnutrition (Skipper, 2012). Consequently, the diagnostic criteria reported in the literature vary widely leading to confusion and the potential for misdiagnosis. It should be recognised that nutrition screening tools determine the risk of malnutrition and diagnoses made using these tools may not be accurate. Nutrition screening tools, such as the Malnutrition Screening Tool (Ferguson *et al.*, 1999), Malnutrition Universal Screening Tool (Stratton *et al.*, 2004) and Simplified Nutritional Assessment Questionnaire (Wilson *et al.*, 2005) may be used by any trained person as a simple and timely method to identify patients who may be at risk of malnutrition and require further nutrition assessment by a dietitian (Watterson *et al.*, 2009; Skipper, 2012). The development of global nutrition assessment tools such as the Mini Nutritional Assessment (MNA) (Guigoz *et al.*, 1994; Neumann *et al.*, 2007) and Subjective Global Assessment (SGA) (Detsky *et al.*, 1987) are accepted and valid methods of nutrition assessment, and provide sufficient information for qualified health professionals to use their clinical judgement to make a diagnosis of malnutrition. These nutrition assessment tools overcome the limitations of nutrition screening tools or individual markers by encompassing multiple criteria, such as measures of anthropometry and assessment of oral intake. The MNA and SGA are the only nutrition assessment tools with sufficient

evidence for appropriate use in the rehabilitation and community settings according to best practice guidelines (Detsky *et al.*, 1987; Neumann *et al.*, 2007; Watterson *et al.*, 2009).

The present study aimed to determine the association between malnutrition in older adults admitted for rehabilitation and nutrition status, functional status, quality of life, institutionalisation, acute care admissions and mortality once discharged to the community. Secondary objectives were to explore the extent to which malnutrition-focused interventions may impact upon these post-discharge outcomes in older adults and to describe the types of interventions used.

Materials and methods

A systematic literature review of current evidence was conducted.

Search strategy

Published English-language studies were searched for in the electronic databases CENTRAL, CINAHL (via Ebscohost), EMBASE, Health Source: Nursing/Academic Edition, PubMed and Web of Science for publications from 1990 to the 31 January 2013. The search strategy used each databases' controlled vocabulary. The search strategy was complemented by a 'snowball' search of cited papers.

PubMed and CENTRAL was searched using the MeSH Terms:

(*Protein energy malnutrition* OR *Malnutrition* OR *Nutritional status* OR *Nutrition assessment*) AND (*Rehabilitation* OR *Rehabilitation centers*)

CENTRAL was also searched using the same MeSH terms as keywords in the title, abstract and keywords. CINAHL (via Ebscohost) was searched using the CINAHL Headings:

(*Malnutrition* OR *Protein-energy malnutrition* OR *Nutrition* [as keyword – subject]) AND (*Rehabilitation* OR *Rehabilitation centers* OR *Rehabilitation patients*).

Health Source: Nursing/Academic Edition (via Ebscohost) was searched using the following Health Source Subjects:

(*Malnutrition* [exp] OR *Nutrition disorders in old age* OR *Nutrition* [as keyword – abstract/title]) AND (*Rehabilitation* OR *Rehabilitation centers*)

EMBASE was searched for citations from both EMBASE and MEDLINE using Emtree terms:

(*Malnutrition/exp* OR '*Protein calorie malnutrition*'/*exp* OR '*Nutritional assessment*'/*exp* OR '*Nutritional status*'/*exp*) AND ('*Cancer rehabilitation*' OR '*Functional assessment*' OR '*Geriatric rehabilitation*' OR '*Muscle training*' OR '*Pulmonary rehabilitation*' OR

'Vocational rehabilitation' OR 'Rehabilitation care' OR 'Rehabilitation center' OR 'Rehabilitation patient' OR 'Rehabilitation research' NOT (Child* OR Paed* OR Pediatric OR Dialysis* OR Acute OR 'Nursing home' OR Residential [as keywords])

Web of Science was also searched for the following keywords in topic or title:

[(Nutrition OR Malnutrition) AND Rehabilitation] NOT Parenteral NOT Tube NOT Child* NOT Pediatric NOT Infant NOT Nursing home NOT Acute NOT Dialysis NOT Mice NOT Rat

A list of outcome measures meaningful to the review's primary objective was developed to identify the relevant research. These outcome measures include:

- Mini Nutritional Assessment (MNA)
- Mini Nutritional Assessment – Short Form (MNA-SF) (Rubenstein *et al.*, 2001; Charlton *et al.*, 2010)
- Subjective Global Assessment (SGA)
- functional status (any validated tool)
- quality of life (any validated tool)
- institutionalisation (admission to long-term care, nursing home, residential home; events, costs)
- hospitalisation (general, emergency, intensive care unit, rehabilitation; events, costs)
- mortality (up to 3 years post-discharge).

Inclusion criteria for types of participants were older adults (mean age of study sample ≥ 65 years) (AIHW, 2010) admitted as an in-patient to a rehabilitation ward, centre or unit. Inclusion criteria for types of studies were intervention studies of any kind that had more than one point of data collection, and observational studies that were prospective or retrospective cohorts, case series, all or none and case-control studies. Studies were included only if nutrition assessment was conducted during rehabilitation admission (outcomes 1, 2 or 3 measured at baseline) and if any one outcome of interest was measured once discharged to the community (outcomes 1, 2, 3, 4, 5, 6, 7 or 8 at post-discharge follow-up). Intervention papers were included if any form of nutrition intervention was delivered to the population group either during rehabilitation or post-discharge to the community.

Exclusion criteria for types of participants included populations that had cystic fibrosis, were receiving drug and alcohol rehabilitation, ambulatory rehabilitation, enteral or parental tube feeding, haemodialysis or peritoneal dialysis. Intervention studies were excluded if the intervention had no nutritional component or focused on improving control of diabetes or cardiovascular risk factors. Exclusion criteria for types of studies included cross-sectional studies (because the design does not allow for outcomes to be assessed during rehabilitation and post-discharge to the community), protocol studies, abstracts, conference papers and review papers. Studies that

reported malnutrition by using a nutrition screening tool or single marker such as serum albumin or weight loss were excluded, as were those that failed to assess nutrition status during rehabilitation or any outcome of interest once discharged to the community.

Selection of studies and data synthesis

A two-step screening process was employed. In step 1, one investigator scanned the titles and abstracts of studies identified by the search for their eligibility. At step 2, full-text articles were screened by one investigator for eligibility. Data were extracted from the published papers into standardised tables by one investigator. In the tables, results of studies were reported only for the outcome measures of interest. Results were reported as significant at $P < 0.05$ and no exclusions were made for type of statistical approach. As well as the study design, the study population was described.

Review of study strength and quality

The strength of studies was determined using the National Health and Medical Research Council (NHMRC) levels of evidence according to the type of research question (Coleman *et al.*, 2005). The NHMRC levels of evidence provide a guide to the strength of evidence addressing clinical questions based on a hierarchy of study design, and are graded I (strongest) to IV (weakest). The quality of studies, including risk of bias and appropriate statistical analysis, was assessed using the Academy of Nutrition and Dietetics' Quality Criteria Checklists for primary research and designated with a positive (+, strong quality), neutral (Ø, neither strong nor weak quality) or negative (–, weak quality) assessment (AND, 2009). A review of strength and quality of studies was conducted by one investigator and checked by a second investigator. Where the investigators did not agree, a third investigator was approached.

Results

Search results

The search identified 2236 citations, of which 115 were considered potentially relevant at step 1 based on the information in the title and abstract (Fig. 1). A further two potentially eligible papers were identified during the 'snowball' search. Using an inclusion/exclusion form, five studies were identified as eligible for full review at step 2 (Table 1). The main reason that studies were excluded ($n = 43$ studies) was a result of an ineligible study design, such as cross-sectional studies or studies that did not measure outcomes following discharge to the community.

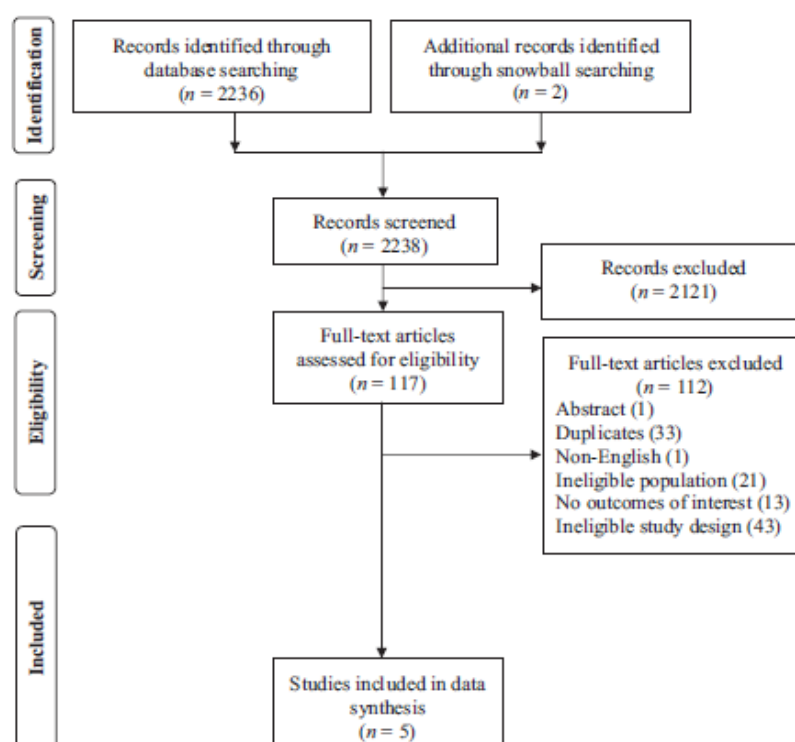


Figure 1 Study flow diagram.

Table 1 Characteristics of identified studies

Citation	Setting	Study design	Study sample	Attrition (%)	NHMRC level (Coleman <i>et al.</i> , 2005)	AND quality (AND, 2009)
Charlton <i>et al.</i> (2012)	Two rehabilitation hospitals. Unknown bed numbers. NSW, Australia	Retrospective cohort study	≥65 years, mean = 80.2 years (± 7.1 years) n = 469 Data collected: 2006–2009	0	III-3 – Prognosis evidence	+
Neumann <i>et al.</i> (2005)	55 bed rehabilitation unit at a general hospital. SA, Australia	Prospective cohort study	≥65 years, mean = 81 years (± 6 years) n = 133 Data collected: 2003	13	II – Prognosis evidence	Ø
Nicosia <i>et al.</i> (2012)	70 bed rehabilitation unit. Lombardy, Italy	Prospective cohort study	≥65 years, mean = 79–81 years n = 243 Data collected: 2007–2008	10	II – Prognosis evidence	+
Sullivan <i>et al.</i> (1991)	20 bed rehabilitation unit in a Veterans Administration hospital. Arkansas, USA	Prospective cohort study	Mean = 78 years (± 9 years) n = 110 Data collected: 1987–1988	31	II- Aetiology evidence	+
Visvanathan <i>et al.</i> (2004)	Medical, orthopaedic and geriatric wards at a rehabilitation centre. Unknown bed numbers. SA, Australia	Prospective cohort study	≥65 years, mean = 76–79 years n = 65 Data collected: 2002–2003	0	II – Prognosis evidence	Ø

AND, Academy of Nutrition and Dietetics; NHMRC, National Health and Medical Research Council; NSW, New South Wales; SA, South Australia.

In the 12 ineligible studies that did not measure outcomes of interest, all 12 failed to use the MNA, MNA-SF or SGA to identify malnutrition. Instead, these studies

used various measures such as serum albumin, body mass index or body circumference alone or in combination, thereby failing to provide a reliable diagnosis of protein-

energy malnutrition. Of consequence, no intervention studies were identified that included outcome measures following discharge from rehabilitation to the community. Although not an intervention study, Visvanathan *et al.* (2004) reported that patients with moderate to severe malnutrition received nutritional supplements as a matter of routine clinical care. The intervention was not described in detail.

Three studies were conducted in Australia with data collected from 2003–2009 (Visvanathan *et al.*, 2004; Neumann *et al.*, 2005; Charlton *et al.*, 2012), one from the USA (1987) (Sullivan *et al.*, 1991) and one study conducted in Europe (2012) (Nicosia *et al.*, 2012). All studies reported similar study populations with mean ages of 76–81 years, and sample sizes ranged widely ($n = 65$ –469) with a total of 1020 participants from the five studies (Table 1). Outcome measures post-discharge from rehabilitation to the community ranged from immediately following discharge to 26 months.

Review of study strength and quality

The strength of the studies was high, with four of five being prospective cohort studies. The studies by Neumann *et al.* (2005), Nicosia *et al.* (2012) and Visvanathan *et al.* (2004) provide level II prognosis evidence and the study by Sullivan *et al.* (1991) provides level II aetiology evidence. The largest study (Charlton *et al.*, 2012) was a retrospective cohort study providing level III-3 prognosis evidence. The quality of studies was good, with those of Charlton *et al.* (2012), Sullivan *et al.* (1991) and Nicosia *et al.* (2012) being assessed as positive quality, and those of Neumann *et al.* (2005) and Visvanathan *et al.* (2004) being assessed as neutral. Although the study by Sullivan *et al.* (1991) was found to have positive quality, there was a high level of attrition (31%). There were no conflicts in assessment of study strength and quality between the investigators.

The consequences of malnutrition following discharge from rehabilitation to the community

Table 2 describes the outcomes of the included studies. The MNA-SF and MNA were used by four studies to identify malnutrition, with the SGA used once. Visvanathan *et al.* (2004) used two different techniques to calculate malnutrition using the MNA. Traditional scoring (≤ 24 indicating risk of malnutrition) was considered in this review. Nutrition assessment was conducted within 4 days of admission in all studies, except where Nicosia *et al.* (2012) did not report the timing of nutrition assessment, indicating that older adults were malnourished during admission.

Mortality was the sole dependent variable in two studies ($n = 353$ participants in total; 1 and 2 year follow-up) and no association with malnutrition was identified (Sullivan *et al.*, 1991; Nicosia *et al.*, 2012). In the larger study by Charlton *et al.* (2012), malnourished older adults were 3.4 times more likely to die than well-nourished older adults ($n = 469$ participants; 26 months follow-up); however, the increased rate of death for risk of malnutrition in this population was not significant.

Physical function, as measured by the Modified Barthel Index at 90 days post-discharge (Neumann *et al.*, 2005), was found to significantly decrease with risk of malnutrition as determined by both the MNA ($P = 0.002$) and MNA-SF ($P = 0.001$). Similarly, the risk of malnutrition measured by both the MNA ($P = 0.001$) and MNA-SF ($P = 0.009$) was associated with a decreased quality of life, via the Assessment of Quality of Life Instrument, 90 days post-discharge (Neumann *et al.*, 2005).

The risk of admission to higher level care, such as residential facilities, was found to increase in malnourished older adults admitted for rehabilitation (three studies; $n = 667$ participants in total) (Visvanathan *et al.*, 2004; Neumann *et al.*, 2005; Charlton *et al.*, 2012). Visvanathan *et al.* (2004) also found that malnourished older adults admitted for rehabilitation were more likely to be admitted to an acute care facility directly upon discharge from rehabilitation; however, Charlton *et al.* (2012) found no significant results regarding rehospitalisation. Neither nutrition status, nor the cost of health and aged care was measured post-discharge to the community in any of the studies identified.

Discussion

The results of the present review suggest that malnutrition in older adults admitted for rehabilitation will have a negative effect on their functional recovery and quality of life following discharge to the community. In addition, malnourished older adults are more likely to die or to be admitted to higher level care or acute care than be discharged to the community, which may have a confounding effect on quality of life. It is unfortunate that no study repeated a measure of nutrition status at the time of discharge or post-discharge to the community, and therefore it remains unknown whether older adults discharged from rehabilitation were malnourished at the time of discharge, are at risk of continued malnutrition or are at higher risk of developing malnutrition once in the community. However, the increased risk of poor physical function and mortality suggests that this is the case. Identifying and treating malnourished community-dwelling older adults is challenging as a result of the limited access of affordable services, and interventions

Table 2 Outcomes of identified studies

Citation	Baseline outcomes and cross-sectional results	Time point of outcome measure	Post-discharge associations
Charlton <i>et al.</i> (2012)	Measured within 72 h of admission MNA*: median 20 (16–22.5), 53.1% at risk or malnourished	Outcome measures up to 26 months post-discharge, mean follow-up was 18.97 months (± 3.84 months)	Mortality: increased chance of death associated with malnutrition but not risk of malnutrition Malnutrition via MNA hazard rate 3.41, 95% CI (1.07–10.87), times well-nourished Institutionalisation: admission to nursing homes and hostels associated with risk of and malnutrition Discharged to a higher level of care than prior to admission: risk of malnutrition via MNA 50% versus well-nourished 4.9% Risk of malnutrition via MNA 23.4% admitted versus well-nourished 7.8% Malnutrition via MNA 44.3% admitted versus well-nourished 7.8% Risk of malnutrition via MNA 67.7% versus well-nourished 7.8% Hospitalisation: no association
Neumann <i>et al.</i> (2005)	Measured within 4 days of admission MNA*: mean 23 (± 4.0), 53% at risk or malnourished MNA-SF†: mean 10.4 (± 2.7), 62% at risk of malnutrition	Outcome measures 90 days from baseline for physical function and quality of life; immediate post-discharge outcome for institutionalisation	Physical function via MBI‡: poorer physical function associated with risk of and malnutrition Risk/malnutrition via MNA mean 85 (± 19) versus well-nourished mean 96 (± 7) Risk of malnutrition via MNA-SF mean 86 (± 18) versus low risk mean 97 (± 7) Quality of life via AQL§: poorer quality of life associated with risk of and malnutrition Risk of malnutrition via MNA-SF mean 16 (± 6) versus low risk mean 13 (± 5) Risk of malnutrition via MNA mean 17 (± 6) versus low risk mean 12 (± 5) Institutionalisation: admission to higher level care associated with risk of and malnutrition Risk of malnutrition via MNA-SF RRR 2.22, 95% CI (1.02–4.82) Risk of malnutrition via MNA RRR 2.29, 95% CI (1.09–4.80)
Nicosia <i>et al.</i> (2012)	Measured at an unknown point during admission MNA-SF: results not reported	Outcome measures 2 years from baseline	Mortality: no association
Sullivan <i>et al.</i> (1991)	Measured within 2 days of admission SGA¶: results not reported	Outcome measures 1 year post-discharge	Mortality: no association
Visvanathan <i>et al.</i> (2004)	Measured within 2 days of admission MNA: 43.1% at risk or malnourished	Immediate post-discharge outcome	Institutionalisation: admission to higher level care associated with risk of and malnutrition Risk of malnutrition 17.9% admitted versus well-nourished 8.1% Hospitalisation: admission to an acute care facility directly upon discharge from rehabilitation Risk of malnutrition 32.1% admitted versus well-nourished 13.5%

*Range of the full MNA is 0–30 points, where <17 indicates malnutrition, 17–23.5 indicates risk of malnutrition and 24–30 indicates normal nutritional status (Rubenstein *et al.*, 2001; Vellas *et al.*, 2006).

†Range of the MNA-SF is 0–14 points, where 0–7 indicates malnutrition, 8–11 indicates risk of malnutrition and 12–14 indicates normal nutritional status (Rubenstein *et al.*, 2001; Vellas *et al.*, 2006).

‡Range of the MBI is scored 0–99, where 0–24 indicates total dependency, 25–49 indicates severe dependency, 50–74 indicates moderate dependency, 75–90 indicates mild dependency, and 91–99 indicates minimal dependency (Shah *et al.*, 1989).

§Range of the AQL is 0–30, with lower scores indicating better quality of life (Neumann *et al.*, 2005).

¶The SGA is scored categorically, where A indicates well nourished, B indicates mild-moderately malnourished, and C indicates severely malnourished (Detsky *et al.*, 1987).

AQoL, Assessment of Quality of Life Instrument; CI, confidence interval; MBI, Modified Barthel Index; MNA, Mini Nutritional Assessment; MNA-SF, Mini Nutritional Assessment Short Form; RRR, relative risk ratio; SGA, Subjective Global Assessment.

addressing how to provide treatment in this setting, such as educating caregivers, are needed (Marshall *et al.*, 2013). Indeed, a study of stroke rehabilitation patients found that indicators of malnutrition, such as low body weight, were more prevalent following discharge from rehabilitation in older adults that did not receive community care services (Finestone *et al.*, 1995). In this regard, the lack of intervention studies is important because rehabilitation may be an ideal setting to prevent poor outcomes in this subpopulation of community-dwelling older adults.

Several studies have found an association between indicators of malnutrition, such as low muscle mass and weight loss with outcomes post-discharge from rehabilitation to the community. Brynningsen *et al.* (2007) found that older adult stroke rehabilitation patients had no significant change in body mass index or weight from admission to 6 months post-discharge to the community. However, low subscapular skinfold thickness was predictive of non-elective hospital readmission within 3 months of discharge from a geriatric rehabilitation unit (Sullivan, 1992). In this review, these single measures of 'nutrition status' were not considered as a diagnosis of malnutrition. Although they may be indicators of malnutrition in some circumstances, and although they may correlate with poor outcomes, there is no assurance that the measure is a result of true protein-energy malnutrition (Watterson *et al.*, 2009).

In the two studies that failed to find a significant association between malnutrition during rehabilitation and post-discharge mortality, perhaps the studies were underpowered to detect a change in this dependent variable because the study by Charlton *et al.* (2012) did identify a strong association, possibly as a result of a large sample size. Interestingly, Sullivan *et al.* (1991) found that percentage body weight lost 1 year prior to rehabilitation was highly associated with mortality 1 year post-discharge to the community, suggesting that prior community and/or acute care malnutrition may also be predictive of mortality in those discharged from rehabilitation. To support this hypothesis, Donini *et al.* (2004) and Charlton *et al.* (2012) found that older adults were more likely to die during rehabilitation if they were malnourished at admission.

The focus of intervention research in populations discharged from inpatient health services to the community to date appears to be in acute care arena, where malnutrition is highly prevalent and nutrition support delivered post-discharge has been found to improve physical function in community-dwelling older adults (Jensen & Hessov, 2000; Agarwal *et al.*, 2012). Additionally, treatment offered during acute admissions has seen improvements in functional recovery during subsequent

rehabilitation (Gunnarsson *et al.*, 2009). However, the populations admitted to acute care and rehabilitation have significant differences in health status and treatment goals, and the results cannot be extrapolated from acute care studies to other populations with confidence. In the rehabilitative setting, nutrition interventions delivered to older adults have been found to improve nutrition status, physical function and quality of life at the time of discharge (Babineau *et al.*, 2008; Chasen & Bhargava, 2010); however, it is unknown whether these effects continue into the community in this population because no interventions with continuing support or a repeat of outcome measures, post-discharge to the community, have been reported. The present review highlights that there is no current evidence to suggest that nutrition interventions delivered in the rehabilitation setting have an impact on the long-term nutrition and health status of community dwelling older adults. Therefore, no recommendations can be made for best practice to prevent malnutrition in community-dwelling older adults discharged from rehabilitation, thus identifying an evidence gap in the continuum of care for malnourished older adults.

Limitations

The present review is limited by publication bias and may have missed potentially relevant papers if they were not coded accurately in each databases controlled vocabulary. The results reported in the present review are not supported by clinical trials and are observational in nature; however, four of the five studies provide the highest level of observational research and have a low risk of bias. Although the studies identified and included in the present review were of high quality and strength, the overall contribution to the evidence is limited as a result of the small number and heterogenic nature of studies measuring outcomes of interest in this field. Only two studies utilised risk analysis as part of their statistical approach, thereby increasing the strength of results for increased risk of institutionalisation and mortality compared to other findings (Neumann *et al.*, 2005; Charlton *et al.*, 2012).

Conclusions

Malnutrition in older adults admitted for rehabilitation is associated with poorer physical function and quality of life and may increase risk of institutionalisation, hospitalisation and mortality once discharged to the community. There is a lack of quality evidence for nutrition support along the continuum of care for malnourished older adults, where further observational and intervention research is needed post-discharge from rehabilitation to the community. Studies should aim to determine

nutrition status using validated nutrition assessment tools such as the MNA and SGA. Further research of this nature will provide evidence to ensure that rehabilitative nutrition services deliver meaningful input and encourage a healthy ageing population.

Conflict of interests, source of funding and authorship

The authors declare that there are no conflicts of interest.

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S.M. carried out the literature review, data extraction and analysis, interpretation of data, and drafting and revision of the manuscript. SM and EI reviewed the study quality and strength. JB and EI provided supervision, guidance and revision of the manuscript. All authors critically reviewed the manuscript and approved the final version submitted for publication.

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4.2.3 Further details of search results

The details of the systematic review are described in the publication; however table 4. 3 below provides further detail about the outcomes of database searching.

Table 4.3: Number of citations generated and full-texts extracted from the search of seven databases for the consequences of malnutrition following discharge from rehabilitation to the community

Database	Generated citations	Extracted citations
Pubmed	818	25
CENTRAL MeSH Terms	54	2
CENTRAL keywords	80	8
CINAHL	84	12
Health Source	11	4
Web of Science	923	45
Embase	266	19
	2236	115

4.2.4 Statement of contribution to publication by authors

Skye Marshall carried out the literature review, data extraction and analysis, interpretation of data, drafting and revision of the manuscript; Skye Marshall and Elizabeth Isenring reviewed study quality and strength; Judith Bauer and Elizabeth Isenring provided supervision, guidance and revision of the manuscript.

4.2.5 Conclusion and implications of findings

This systematic review aimed to determine the association between malnutrition in older adults admitted for rehabilitation and nutrition status, functional status, quality of life, institutionalisation, acute care admissions and mortality once discharged to the community. The review found that malnutrition in older adults admitted for rehabilitation may result in poorer physical function and quality of life and may increase risk of institutionalisation, hospitalisation and mortality once discharged. There is a strong need for high quality observational research to determine the risk of malnutrition in older adults as they transition from rehabilitation to the community. There is also need for further examination of the validity of nutrition screening and assessment tools used in this setting to ensure accurate diagnosis of malnutrition on entry to the rehabilitation setting. In addition, studies to evaluate the effectiveness of nutrition intervention on transition from the rehabilitation setting to the community are needed to understand how best to provide nutrition care to

optimise health outcomes and prevent malnutrition in older adults. Before evaluating nutrition interventions, clinicians and researchers need to better understand the needs of patients, and their caregivers, during and after the rehabilitation stay to support their transition back to the community. Studies should determine nutrition status using validated tools and report associations with relevant and meaningful outcomes both during admission and post-discharge to any setting. Further research in this subpopulation is necessary in order to encourage a healthy ageing population in Australia.



PART III

MALNUTRITION IN THE OLDER AUSTRALIAN RURAL REHABILITATION COMMUNITY

CHAPTER 5

THE IDENTIFICATION OF MALNUTRITION IN GERIATRIC REHABILITATION

5.1 Background

The systematic literature review described in chapter 4 found that older adults admitted to rehabilitation with malnutrition had poorer HRQoL and increased physical dysfunction, hospitalisation, institutionalisation and mortality once discharged to the community (Marshall et al., 2014). Chapter 4 concluded that understanding the nutritional journey older adults make from rehabilitation to home will help target nutrition screening and intervention programs. This is of particular importance in rural and remote Australia, due to the increased challenges in accessing, identifying and treating community-dwelling older adults with chronic disease (2011b) (chapter 1.2.3).

Due to the importance of preventing, identifying and treating malnutrition in order to maximise patient outcomes, it has been argued that every older inpatient should be screened for the condition, followed by repeated nutrition assessments and appropriate treatment if found at risk of malnutrition (Cudennec et al., 2011). Nutrition screening and assessment are often completed through the application of a nutrition screening tool and nutrition assessment tool (Lacey & Prichett, 2003). However, the nutrition screening and assessment tools chosen should be validated for the population to which they are applied. In the rehabilitation setting, the evidence-based practice guidelines recommend two nutrition screening tools which have been evaluated for their validity, the MNA-SF (Rubenstein et al., 2001) and the Rapid Screen (Visvanathan et al., 2004); however, the MST has not been evaluated (Watterson et al., 2009). Regarding nutrition assessment tools, the guidelines recommend the MNA and the SGA; however, the Scored PG-SGA has not been evaluated for validity (Watterson et al., 2009).

Therefore, there is a need to evaluate the validity of these commonly used nutrition screening and assessment tools in the geriatric rehabilitation setting. There is also a need to explore the nutritional journey of that older adults make throughout their rehabilitation admission and transition back to the rural community, and the role that informal caregivers may have in supporting this journey. Therefore, the MARRC Study (Malnutrition in the Australian Rural Rehabilitation Community) was undertaken from August 2013 to January 2016. The details of the MARRC Study aims, methods, results and conclusions are described in chapters 5, 6 and 7 below.

5.2 Nutrition screening in rural geriatric rehabilitation

5.2.1 Introduction

In chapter 2, the role nutrition screening plays in identifying malnutrition in a variety of settings has been described. In summary, nutrition screening is an essential practice in settings such as rehabilitation and acts as a trigger for nutrition assessment and subsequent nutrition intervention (Skipper et al., 2012; Watterson et al., 2009).

In the rehabilitation setting, there are only two screening tools which have been evaluated for validity (Watterson et al., 2009). These include the MNA-SF (appendix VII) and the Rapid Screen, (not included in appendices as it is not a copyrighted screening tool). As there is no gold standard for diagnosing malnutrition, in order to establish a screening or assessment tool as “valid”, the criterion validity must be established. Criterion validity represents how well a particular variable predicts an outcome compared to other variables, and encompasses concurrent and predictive validity (2012b). Concurrent validity is determined by comparing the score of a new measurement to the score of a well-established measurement for the same construct. When evaluating the concurrent validity of a nutrition screening tool, sensitivity is considered of higher importance than specificity and *a-priori* values of $\geq 80\%$ for sensitivity and $\geq 60\%$ for specificity are considered to indicate a good nutrition screening tool (Ferguson et al., 1999a). Predictive validity is established when the score of a particular measurement makes an accurate prediction about the construct they represent.

In the study which evaluated the validity of the MNA-SF, the MNA-SF showed ‘substantial agreement’ (kappa 0.626) with a diagnosis of malnutrition in the rehabilitation setting; however, this study did not report sensitivity or specificity and the full MNA was used as the benchmark to identify malnutrition (Kaiser et al., 2011). The two-item Rapid Screen reported moderate sensitivity (78.6%) and excellent specificity (97.3%) (Visvanathan et al., 2004) compared with a standardised nutrition assessment in geriatric rehabilitation (Visvanathan et al., 2004).

The MNA-SF was designed specifically for an older population, and is perhaps the most widely reported nutrition screening tool in the literature across health care settings (Watterson et al., 2009); however, the MST (appendix VIII) is the most common nutrition screening tool used in Australian hospitals (Ferguson et al., 2010). For example, the MST is currently the screening tool featured on the admission intake assessment form in all facilities in the Northern New South Wales Local Health District, including acute care and

rehabilitation units (Hoffman, 2010). Despite the widespread use of the MST in the Australian rehabilitation setting, it has not been evaluated for validity.

Therefore, although widely used by clinicians, the MNA-SF and MST require further examination of their criterion validity in the Australian geriatric rehabilitation setting. As the ICD-10-AM classification for malnutrition (chapter 2.5.3) is the agreed upon standard to identify malnutrition in the Australian health care setting, it was used as the benchmark for establishing the concurrent validity of each screening tool, a precedent which has recently been established in similar studies (Bell et al., 2014a; Bell et al., 2014b). The predictive validity was evaluated by determining if the MNA-SF and MST “at risk” categories are able to discern the difference in rates of rehospitalisation, institutionalisation and discharge location; health-related outcomes which were found to be associated with malnutrition in the sample population. Therefore, the aim of this study was to determine the criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and Mini Nutritional Assessment-Short Form (MNA-SF) in older adults admitted to inpatient rehabilitation facilities.

5.2.2 Publications

Marshall S, Young A, Bauer J, Isenring E. Nutrition screening in geriatric rehabilitation: Criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and the Mini Nutritional Assessment-Short Form (MNA-SF). *Journal of the Academy of Nutrition and Dietetics*. 2016; 116(5):795-801⁶. *Number of citations by date of thesis submission: 2.*

This study has also been published and presented elsewhere:

- *Published abstract:* **Marshall S**, Young A, Bauer J, Isenring E. Nutrition screening in geriatric rehabilitation: Criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and the Mini Nutritional Assessment-Short Form (MNA-SF) [Abstract]. *Nutrition & Dietetics*. 2015:72(S1):53.
- *Oral presentation:* **Skye Marshall**, Adrienne Young, Judith Bauer, Elizabeth Isenring. Criterion validity of nutrition screening and assessment tools in geriatric rehabilitation. *DAA Qld Branch Professional Development event “3 Minutes to Shine” session, Brisbane, July 2015.*

⁶ Page numbers of the featured publication correspond with the journal publication and not with this thesis.

- *Poster presentation: **Skye Marshall**, Adrienne Young, Judith Bauer, Elizabeth Isenring. Nutrition screening in geriatric rehabilitation: Criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and the Mini Nutritional Assessment-Short Form (MNA-SF). Presented at the Dietitian Association of Australia's National Conference in Perth, May 2015.*
- *Poster presentation: **Skye Marshall**, Adrienne Young, Judith Bauer, Elizabeth Isenring. Nutrition screening in geriatric rehabilitation: Criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and the Mini Nutritional Assessment-Short Form (MNA-SF). Presented at Bond University Faculty of Health Sciences and Medicine Higher Degree Research Conference, Robina, November 2015.*



Nutrition Screening in Geriatric Rehabilitation: Criterion (Concurrent and Predictive) Validity of the Malnutrition Screening Tool and the Mini Nutritional Assessment—Short Form



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ABSTRACT

Background Nutrition screening is required for early identification and treatment of patients at risk for malnutrition so that clinical outcomes can be improved and health care costs reduced.

Objective To determine the criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and Mini Nutritional Assessment—Short Form (MNA-SF) in older adults admitted to inpatient rehabilitation facilities.

Design Observational, prospective cohort.

Participants/setting Participants were 57 adults aged 65 years and older (mean±standard deviation age=79.1±7.3 years) from two rural rehabilitation units in New South Wales, Australia.

Main outcome measurements MST; MNA-SF; *International Statistical Classification of Diseases and Health Related Problems, 10th revision, Australian Modification* (ICD-10-AM) classification of malnutrition; rehospitalization; admission to a residential aged care facility (institutionalization); and discharge location.

Statistical analysis performed Measures of diagnostic accuracy with 95% CIs generated from a contingency table, Mann-Whitney *U* test, and χ^2 test.

Results When compared with the ICD-10-AM criteria, the MST showed stronger diagnostic accuracy (sensitivity 80.8%, specificity 67.7%) than the MNA-SF (sensitivity 100%, specificity 22.6%). Neither the MST nor the MNA-SF was able to predict rehospitalization, institutionalization, or discharge location.

Conclusions The MST showed good concurrent validity and can be considered an appropriate nutrition screening tool in geriatric rehabilitation. The MNA-SF may overestimate the risk of malnutrition in this population. The predictive validity could not be established for either screening tool.

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NUTRITION SCREENING IS REQUIRED FOR EARLY identification and treatment of patients at risk of protein-energy malnutrition (termed *malnutrition* throughout) and should occur routinely in all health care settings.¹ Nutrition screening tools are used to identify risk of malnutrition.² They should be quick and simple to implement and able to be used by any trained person or the patient themselves. Once risk is identified, a diagnosis of malnutrition should be made by a qualified health professional, such as a registered dietitian nutritionist, after a more comprehensive assessment of nutrition status.³ It is critical

that nutrition screening tools are validated for the population to which they are applied so that patient outcomes can be improved and resources are used efficaciously.³

Rehabilitation facilities are subacute health care facilities where patients are admitted when they require medical and multidisciplinary treatment with the purpose of increasing independence.¹ Rehabilitation patients typically have a chronic illness, such as chronic obstructive pulmonary disease or Parkinson's disease, or are recovering from an acute illness, such as a stroke or hip fracture. Because of the nature of rehabilitation facilities, the majority of patients are older adults. Malnutrition in older adults admitted to rehabilitation is associated with adverse clinical outcomes and mortality during admission,⁴ and poorer quality of life and increased levels of physical dysfunction, hospitalization, institutionalization, and mortality once discharged to the community.^{5,6} Older adults are often transferred to rehabilitation from acute-care facilities, where they might have developed malnutrition as a result of their

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illness or imposed treatments. Therefore, early and accurate identification of malnutrition risk when admitted to rehabilitation facilities is important for attaining a successful rehabilitation outcome and decreasing the economic burden of malnutrition in the older adult community.

Skipper and colleagues⁷ have recently reviewed the nutrition screening tools that have been developed for identifying risk of malnutrition in a variety of settings, including the Malnutrition Screening Tool (MST).⁸ The review concluded that the MST was the only nutrition screening tool of the 11 identified that was supported by studies espousing its validity and reliability. The MST has been widely adopted by health care facilities because of the low cost of implementation and low participation burden.⁸ Since its development in acute-care patients, the MST has also been shown to be valid in oncology outpatients and more recently in residential aged care facilities.⁸⁻¹⁰ In the rehabilitation setting, there are only two screening tools that have been evaluated for validity. These include the Mini Nutrition Assessment–Short Form (MNA-SF)¹¹ and the Rapid Screen.¹² The MNA-SF showed substantial agreement with the full MNA ($\kappa=0.626$; 95% CI 0.507 to 0.744)¹³ and the Rapid Screen reported moderate sensitivity (78.6%) and excellent specificity (97.3%)¹² compared with a standardized nutrition assessment in geriatric rehabilitation. However, the MNA-SF has not been evaluated for its sensitivity or specificity, nor has it been evaluated using a benchmark unrelated to the MNA. The MST has not been evaluated in geriatric rehabilitation, despite being used frequently by practitioners. Therefore, the aim of this study was to determine the criterion (concurrent and predictive) validity of the MST and MNA-SF in older adults admitted to inpatient rehabilitation facilities.

MATERIALS AND METHODS

Study Sample

Participants were older adults admitted to one of two public rehabilitation units in the same local health district in rural New South Wales, Australia.¹⁴ Study centers were chosen by convenience sampling based on location, and participants were consecutively sampled. Participants were English-speaking inpatients aged 65 years and older who were admitted to the participating rehabilitation units, community-dwelling residents before admission, if they were admitted with the expectation they would return to the community, and had an informal caregiver. This study was conducted as part of the MARRC (Malnutrition in the Australian Rural Rehabilitation Community) Study (Trial version 2.0, 9 May 2013), which has been registered at the Australian New Zealand Clinical Trials Registry (ACTRN12613000518763) and has received ethical and governance approval (North Coast NSW Human Research Ethics Committee: LNR 063, G108; School of Human Movement Studies Ethics Committee: HMS13/0731). Written informed consent was obtained from all participants and/or their guardians.

Data Collection

Data used in this observational, prospective cohort study were collected from August 2013 to February 2014. Participant characteristics and nutrition screening and assessment tools were all collected or completed on behalf of the

participant by the primary researcher during an interview at the bedside (median of 2 days after admission) and were further supported by information from medical records, rehabilitation staff, or the patient's informal caregiver.

Nutrition Screening

The MST consists of two questions relating to recent unintentional weight loss and eating poorly, and was scored according to the Queensland Government's resource "Malnutrition. Is your patient at risk?"¹⁵ A score of 2 or higher indicates the patient should be referred to a registered dietitian nutritionist to attend nutrition assessment and intervention, as appropriate.⁸ Therefore, for the assessment of criterion validity, a score of 0 to 1 was used to indicate well-nourished and ≥ 2 was used to indicate risk of malnutrition. The MST was not completed as a separate tool for each participant, but rather a range of data was obtained during a full nutrition assessment, including the two MST questions, which were later used to complete the MST, a method reported by previous researchers.¹⁶ Weight loss was considered in the 6 months leading up to the assessment.

The MNA-SF was completed as a separate tool. The MNA-SF consists of six questions and is scored 0 to 14, where a score of 0 to 7 indicates malnourished, 8 to 11 indicates at risk of malnutrition, and 12 to 14 indicates normal nutrition status.¹⁷ For this study, an MNA-SF score of 12 to 14 was considered well-nourished and 0 to 11 was at risk of malnutrition.

Nutrition Assessment

There is no gold standard for diagnosing malnutrition. The *International Statistical Classification of Diseases and Health Related Problems, 10th revision, Australian Modification* (6th edition, ICD-10-AM)¹⁸ criteria are the recognized standard diagnostic criteria for the identification, documentation, and coding of protein-energy malnutrition and are used to provide case-mix funding reimbursements (Figure). For this reason, the ICD-10-AM classification for malnutrition is an appropriate benchmark to establish the concurrent validity of a nutrition screening tool, and has been used as the standard against which nutrition screening and assessment tools have been validated.^{19,20} The ICD-10-AM classification involves an evaluation of body mass index (BMI; calculated as kg/m^2) to detect chronic malnutrition (BMI <18.5) or weight loss with suboptimal dietary intake resulting in fat and/or muscle wasting to detect acute malnutrition. Failure to identify patients at risk of malnutrition in the health care setting can negatively impact funding²¹; therefore, the nutrition screening and assessment method used must be in agreement with the ICD-10-AM criteria to ensure resources are available for treatment. During nutrition assessment, the components of BMI, weight loss in the 6 months before assessment, a physical evaluation of fat stores and muscle status, and a brief dietary assessment were recorded and used to inform the ICD-10-AM classification of malnutrition for each participant. Any participant meeting the ICD-10-AM criteria of mild, moderate, or severe malnutrition (as per the Figure) was considered to have the condition malnutrition, and if they did not meet any ICD-10-AM criterion they were considered well-nourished.

Weight (kg) was measured to the first decimal point by Tanita InnerScan Body Composition Monitor scales model:

Classification	Definition
E43: Unspecified severe protein-energy malnutrition	In adults, BMI ^a <18.5 or unintentional loss of weight ($\geq 10\%$) with evidence of suboptimal intake resulting in severe loss of subcutaneous fat and/or severe muscle wasting.
E44.0: Moderate protein-energy malnutrition	In adults, BMI <18.5 or unintentional loss of weight (5% to 9%) with evidence of suboptimal intake resulting in moderate loss of subcutaneous fat and/or moderate muscle wasting.
E44.1: Mild protein-energy malnutrition	In adults, BMI <18.5 or unintentional loss of weight (5% to 9%) with evidence of suboptimal intake resulting in mild loss of subcutaneous fat and/or mild muscle wasting.

^aBMI=body mass index; calculated as kg/m².

Figure. The *International Statistical Classification of Diseases and Health Related Problems, 10th Revision, Australian Modification* (6th ed, ICD-10-AM)¹⁸ classifications for protein-energy malnutrition in adults.

BC-541 (Tanita Corporation) by the researcher. If a participant was nonweight-bearing or unable to stand unassisted, then the rehabilitation wards scales were used (chair or roll-on scales). All three scales were within 0.1 kg calibration. Weights recorded for amputees were adjusted.²² Due to the expected high number of bed- or chair-bound participants admitted to rehabilitation, height was calculated by knee height. A sliding knee-height caliper was used to measure the knee height, which was then entered into a population-specific formula to estimate the true height.²² BMI was calculated using measured weight and estimated height. For describing this sample of older adults, a normal BMI was considered 22 to 27, <22 was considered underweight, and >27 overweight/obese.^{23,24}

Health and Aged Care Service Use

Increased health and aged care service use have been associated with malnutrition in the geriatric rehabilitation setting and reflect patient well being and health and aged care costs.⁵ Therefore, discharge location (home/other), rehospitalization (total length of stay of subsequent rehabilitation and acute-care admissions), and institutionalization (admission to residential aged care facilities; yes/no) were chosen to evaluate predictive validity. Discharge location was measured at the time of discharge. Rehospitalization and admission to residential aged care facilities were measured 3 months post discharge. Data were obtained from the health service's electronic admissions database and confirmed by telephone or in-home interviews.

Statistical Approach

All statistical analysis was completed using SPSS software (version 22.0, 2013, IBM SPSS Statistics for Windows). Significance was considered at the $P < 0.05$ level. Descriptive statistics (mean \pm standard deviation and median [interquartile range]) were used to characterize the sample population. χ^2 and independent sample t tests (or Mann-Whitney if nonparametric) were used to assess for a significant difference in descriptors of the sample population by rehabilitation center.

Criterion validity represents how well a particular variable predicts an outcome compared to other variables, and encompasses concurrent and predictive validity.²⁵ Concurrent validity is determined by comparing the score of a new measurement to the score of a well-established measurement for the same construct, in this case, comparing the MST and

MNA-SF nutrition risk categories with a malnutrition diagnosis as per ICD-10-AM classification of malnutrition. Predictive validity is established when the score of a particular measurement makes an accurate prediction about the construct they represent, in this case, we determine whether the MST and MNA-SF risk of malnutrition categories are able to detect the difference in rates of rehospitalization, institutionalization, and discharge location, all of which are health-related outcomes that are associated with malnutrition.

To determine the concurrent validity of the MST and MNA-SF in this sample, measures of diagnostic accuracy were determined. The sensitivity (malnourished/risk of malnutrition correctly identified as such), specificity (well-nourished correctly identified as such), positive predictive value (correctly identified as malnourished/risk of malnutrition within the malnourished sample), negative predictive value (correctly identified as well-nourished within well-nourished sample), a weighted κ -statistic, and diagnostic odds ratio (DOR) with the 95% CI were determined using contingency tables against the ICD-10-AM classification of malnutrition. Sensitivity was considered of higher importance than specificity and *a-priori* values of $\geq 80\%$ for sensitivity and $\geq 60\%$ for specificity were considered to indicate a good nutrition screening tool.⁸ The DOR is a global measure of diagnostic accuracy, where a score of 1 indicates the test is equally likely to predict a positive or negative outcome; whatever the true condition and the higher the ratio, the better the test performance.²⁶

To evaluate the predictive validity of the MST and MNA-SF, the categories of well-nourished and risk of malnutrition were tested for significance with the longitudinal outcomes of rehospitalization length of stay, discharge location, and admission to a residential aged care facilities using the Mann-Whitney U test and χ^2 test.

RESULTS

Study Participants

During the study recruitment period, 57 consecutive rehabilitation inpatients consented to participate in the study (response rate of 98%). The mean \pm standard deviation age was 79.1 \pm 7.3 years; however, there was a significant difference in age between sites (77.5 years vs 81.4 years). Fifty-four percent of participants were at risk of malnutrition according to the MST, 88% according to the MNA-SF, and 46% were malnourished according to the ICD-10-AM criteria. Site B had

Table 1. Characteristics of a cohort of 57 older adults admitted to rural rehabilitation facilities in New South Wales, Australia, overall and by facility

Variable	Site A (n=33)	Site B (n=24)	Total participants (n=57)
<i>mean±SD^a</i>			
Age, y	77.5±7.5	81.4±6.4*	79.1±7.3
<i>%</i>			
Female	39.4	62.5	49.1
<i>mean±SD</i>			
Weight, kg	70.5±18.9	68.3±19.8	69.6±19.1
BMI ^b	25.4±6.4	24.5±4.6	25.0±5.7
<i>%</i>			
Underweight: BMI <22	30.3	29.2	29.8
Overweight/obese: BMI >27	30.3	29.2	29.8
Admission source			
Acute health care facility	81.8	91.7	86.0
Community	18.2	8.3	14.0
Reason for admission			
Acute illness	69.7	79.2	73.7
Chronic illness	30.3	20.8	26.3
<i>mean±SD</i>			
Cognitive impairment^c			
MMSE ^d (n=14)	—	23.1±3.4	—
3MS ^e test (n=20)	79.0±15.9	—	—
<i>%</i>			
Risk of malnutrition			
MST ^f (score ≥2)	39.4	75.0*	54.4
MNA-SF ^g (score <12)	84.5	91.7	87.7
Malnourished ^h	42.4	50.0	45.6

^aSD=standard deviation.^bBMI=body mass index; calculated as kg/m².^cNot compared between sites because of difference in measurement tools.^dMMSE=Mini-Mental State Examination.^e3MS=Modified Mini-Mental State.^fMST=Malnutrition Screening Tool.^gMNA-SF=Mini Nutritional Assessment—Short Form.^hMalnourished according to *International Statistical Classification of Diseases and Health Related Problems, 10th revision, Australian Modification (ICD-10-AM)*¹⁸ classification of protein-energy malnutrition.*Significant difference between sites ($P<0.05$).

a significantly higher proportion of participants considered at risk of malnutrition than site A, according to the MST. Ad-hoc analysis reveals this is due to a higher proportion of participants at site B with decreased dietary intake as well as losing a larger amount of weight. Participant characteristics are shown in Table 1.

Concurrent and Predictive Validity of the MST and MNA-SF

In evaluating its concurrent validity, the MST exceeded *a-priori* values for sensitivity and specificity and had strong

positive predictive value (67.7; 95% CI 48.6 to 83.3) and negative predictive value (80.8; 95% CI 60.6 to 93.4) (Table 2). The MNA-SF showed perfect sensitivity and negative predictive value, but only 22.6% (95% CI 11.4 to 39.8) specificity and 52% (95% CI 37.4 to 66.3) positive predictive value. The DOR of the MST and MNA-SF were similar, showing the screening tools have some diagnostic value; however, the wide 95% CI of the MNA-SF DOR shows this variable might be underpowered and is unreliable. The κ -statistic for the MST showed moderate agreement with the ICD-10-AM classification of malnutrition, whereas the κ -statistic for the MNA-SF was considered fair agreement. With regard to predictive

Table 2. Measures of diagnostic accuracy of the Malnutrition Screening Tool and Mini Nutritional Assessment—Short Form against the *International Statistical Classification of Diseases and Health Related Problems, 10th Revision, Australian Modification* (ICD-10-AM),¹⁸ classification of protein-energy malnutrition in a cohort of 57 older adults admitted to rural rehabilitation facilities in rural New South Wales, Australia

	κ -Statistic	Sensitivity	Specificity	PPV ^a	NPV ^b	DOR ^c	Rehospitalization LOS ^d	Admission to RACF ^e	Discharge location
		← % →					← P value →		
MST^f							0.975	0.493	0.556
Value	0.478 [†]	80.8	67.7	67.7	80.8	8.8			
95% CI	0.193-0.677	62.1-91.5	50.1-81.4	48.6-83.3	60.6-93.4	2.6-30.2			
MNA-SF^g							0.174	0.167	0.125
Value	0.210*	100	22.6	52.0	100	15.2 ^h			
95% CI	0.020-0.210	87.1-100	11.4-39.8	37.4-66.3	58.9-100	0.9-233.3			

^aPPV=positive predictive value.

^bNPV=negative predictive value.

^cDOR=diagnostic odds ratio.

^dLOS=length of stay.

^eRACF=residential aged care facility.

^fMST=Malnutrition Screening Tool.

^gMNA-SF=Mini Nutritional Assessment—Short Form.

^hThe false-negative values for the MNA-SF compared with the ICD-10-AM criteria were zero. However, due to the problems with computation of odds ratios with a zero value, each cell in the contingency table had 0.5 added.²⁷⁻²⁹

* $P < 0.05$, "fair agreement" as per Landis and Koch κ -statistic classification.³⁰

[†] $P < 0.0001$, "moderate agreement" as per Landis and Koch κ -statistic classification.³⁰

validity, neither tool was able to detect a significant difference in rehospitalization length of stay, admission to a residential aged care facility, or discharge location in this sample. Prevalence of these outcomes will be reported elsewhere.³¹

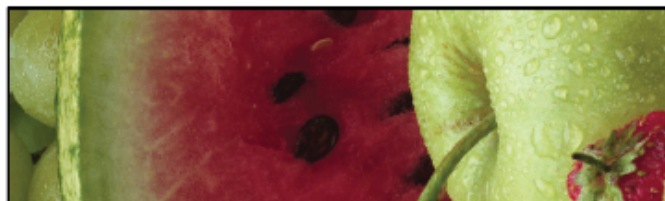
DISCUSSION

This is the first study to evaluate the criterion validity of the MST in the rehabilitation setting and to evaluate the concurrent validity of the MNA-SF in the rehabilitation setting using a benchmark unrelated to the MNA.¹ The MST showed strong concurrent validity when compared with the ICD-10-AM classification of malnutrition in this sample of older adults admitted to rehabilitation. However, the MNA-SF can overestimate risk of malnutrition when compared with ICD-10-AM criteria. Neither tool was able to predict health and aged care use.

The MST performed stronger in this geriatric rehabilitation sample than reported in an acute hip-fracture population ($\kappa=0.363$; sensitivity 60% and specificity 76%), which also used the ICD-10-AM classification as a benchmark.²⁰ This difference in sensitivity and specificity between the two similar populations may be due to how the MST was scored, where the hip-fracture study only scored points for decreased oral intake because of decreased appetite, as opposed to decreased oral intake for any reason, as used in this study. These results suggest that the current method of scoring the MST in older adults may be superior. In the study by Isenring and colleagues,¹⁰ which scored the MST to include decreased oral intake for any reason, the MST also showed strong concurrent validity when compared with the Subjective Global Assessment ($\kappa=0.806$, sensitivity 89% and specificity 94%)

and MNA ($\kappa=0.501$, sensitivity 94% and specificity 81%) in a residential aged care facility setting. There has only been one study evaluating the predictive validity of the MST, where it was found to predict length of stay in 408 adult acute hospital patients.⁸

The low specificity of the MNA-SF was unexpected, as this tool performed better in the acute hip-fracture population, although it still tended to overestimate risk of malnutrition when using <12 as the cut-off value (sensitivity 89%, specificity 49%).²⁰ As mentioned previously, the MNA-SF showed substantial agreement ($\kappa=0.626$) in a previous study evaluating the validity of the MNA-SF in the rehabilitation setting; however, the study did not report sensitivity and specificity and the full MNA was used as the benchmark.¹³ A poor performance of the MNA-SF against other nutrition assessments may be due to the focus of the MNA/MNA-SF being on early identification of malnutrition risk, whereas assessments such as the Subjective Global Assessment and ICD-10-AM focus on diagnosing existing malnutrition.³² Therefore, an overclassification of well-nourished patients as at risk for malnutrition may be appropriate for some well-resourced settings, where prevention of malnutrition is the focus as opposed to treatment.³²⁻³⁴ Despite the MNA-SF's poor specificity, "fair" κ -statistic, and not being able to predict patient outcomes in this study, nutritional risk determined by the MNA-SF has previously been found to be associated with increased risk of institutionalization and decreased physical function and quality of life in geriatric rehabilitation.³⁵ In addition, the original authors suggested lowering the cut-off value of the MNA-SF if an improvement in specificity is required.¹¹



PRACTICE IMPLICATIONS

What Is the Current Knowledge on this Topic?

In the geriatric rehabilitation setting, the MST and the MNA-SF require additional assessment of criterion (concurrent and predictive) validity.

How Does this Research Add to Knowledge on this Topic?

This is the first study to evaluate the criterion validity of the MST in the rehabilitation setting, and to evaluate the concurrent validity of the MNA-SF in the rehabilitation setting using a benchmark unrelated to the MNA.

How Might this Knowledge Impact Current Dietetics Practice?

This study provides the first evidence in support of the MST in the geriatric rehabilitation setting. The MNA-SF overestimated risk of malnutrition in geriatric rehabilitation and may not be appropriate for use.

The inability of the MST and MNA-SF to detect a difference in health and aged care service use may be due to a relatively small sample size. However, as the current sample size had enough power to detect the difference in these outcomes after a diagnosis of malnutrition using the ICD-10-AM criteria,³¹ it may have clinical implications that the MST and MNA-SF did not display predictive validity. These results emphasize the importance of following nutrition screening with a full nutrition assessment in order for resources to be used appropriately and to ensure adequate funding of health care facilities.

Limitations

There is risk of bias with the same researcher conducting the screening and assessment; however, an independent review of assessments by experienced practitioners was conducted to limit bias. As both the MST and MNA-SF were completed by a trained accredited practicing dietitian (Australian-certified) during a full nutrition assessment, the accuracy of tool completion by a person without a nutrition background, such as nursing staff, may not be as high. The next step in evaluating the validity of the MST and MNA-SF should be a larger study with tools completed by trained nondietetics staff during admission and/or by patient self-completion. Further research comparing the Rapid Screen with the MST and MNA-SF would also be of interest. A limitation of using the ICD-10-AM classification of malnutrition as the standard in this population is the BMI cut-off of <18.5 , which is likely to be too low for an older population, where a BMI ≤ 22 is generally considered underweight.^{23,24} This may increase the rate of type II errors, where a chronically malnourished participant was considered well nourished, and may have caused a decrease in the sensitivity of the

nutrition screening tools when compared with the ICD-10-AM classifications.

CONCLUSIONS

The MST is appropriate for use as a nutrition screening tool in geriatric rehabilitation; however, the MNA-SF may overestimate the risk of malnutrition. Neither the MST nor the MNA-SF displayed predictive validity in this sample of older adults admitted to rural rehabilitation units. Nutrition screening should be followed by a full nutrition assessment to identify patients in need of nutrition intervention so that resources may be used efficaciously and patient outcomes improved.

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STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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5.2.3 Statement of contribution to publication by authors

Skye Marshall carried out the data collection, conducted the statistical analysis and interpretation of data, and drafted and revised the manuscript. Judith Bauer, Adrienne Young and Elizabeth Isenring provided supervision, guidance and revision of the manuscript.

5.2.4 Post-hoc power assessment

5.2.4.1 Background

Predictive validity is established when the score of a particular measurement makes an accurate prediction about the construct they represent, in this case we determine if the MST and MNA-SF “risk of malnutrition” categories are able to detect the difference in rates of rehospitalisation, institutionalisation and discharge location. These three outcomes had a significant difference between well-nourished and malnourished participants according to the ICD-10-AM criteria (Marshall et al., 2016a). However, as described in the above study (Marshall et al., 2016b), neither the MST nor the MNA-SF displayed predictive validity for these outcomes.

Therefore, in an attempt to understand these findings, this post-hoc analysis aimed to determine the power of the MST and MNA-SF in predicting rehospitalisation, institutionalisation and discharge location in older adults admitted to rehabilitation.

5.2.4.2 Ethical consideration

This study was conducted between August 2013 and April 2015 as part of the MARRC (Malnutrition in the Australian Rural Rehabilitation Community) Study (trial version 2.0, 9 May 2013) which has been registered at the Australian New Zealand Clinical Trials Registry (ACTRN12613000518763) and has received ethical and governance approval (North Coast NSW Human Research Ethics Committee: LNR 063, G108; School of Human Movement Studies Ethics Committee: HMS13/0731). Written informed consent was obtained from all participants and/or their guardians.

5.2.4.3 Data collection

Discharge location (home/other), rehospitalisation (total length of stay of subsequent rehabilitation and acute care admissions) and institutionalization (admission to RACF; yes/no) were recorded for the evaluation of predictive validity. Discharge location was measured at the time of discharge. Rehospitalisation and admission to an RACF were measured three months post-discharge to the community. Data were obtained from the

health service's electronic admissions database and confirmed by telephone or in-home interviews.

5.2.4.4 Statistical approach

To evaluate the predictive validity of the MST (score of 2 or more indicating risk of malnutrition) and MNA-SF (score of 12 or less indicating risk of malnutrition), the categories of 'well-nourished' and 'risk of malnutrition' were compared with the longitudinal outcomes of rehospitalisation length of stay, discharge location and admission to an RACF. Ad hoc power tests were completed for the longitudinal outcomes using G*Power Version 3.9.1.2 (G*Power: Statistical Power Analyses for Windows and Mac. Düsseldorf : Heinrich-Heine-Universität Düsseldorf).

5.2.4.5 Results and discussion

Ad hoc analysis revealed that the MST was underpowered to detect a difference in rehospitalisation LOS (8% power), admission to an RACF (21% power) and discharge location (10% power). The MNA-SF had 73% power to detect a difference in admission to an RACF and 78% to detect a difference in discharge location, but was underpowered to detect a difference in rehospitalisation LOS (18% power). The inability of the MST and MNA-SF to detect a difference in health and aged care service use is due to a relatively small sample size for the MST as all tests were severely underpowered. The MNA-SF may have had enough power to predict discharge location and admission to an RACF, however, it was not able to predict these outcomes. This may be due to the MNA-SF overestimating risk of malnutrition (87.7% of participants 'at risk of malnutrition').

5.2.5 Conclusion and implication of findings

The aim of this study was to determine the criterion (concurrent and predictive) validity of the Malnutrition Screening Tool (MST) and Mini Nutritional Assessment-Short Form (MNA-SF) in older adults admitted to inpatient rehabilitation facilities. It was the first study to evaluate the criterion validity of the MST in the rehabilitation setting, and the first to evaluate the concurrent validity of the MNA-SF in the rehabilitation setting using a benchmark unrelated to the MNA. These tools are used frequently by practitioners in this setting but this practice has not previously been evidence-based.

This study reveals new and important conclusions about the extent to which the MNA-SF may overestimate nutritional risk, and therefore may not be appropriate for use as a screening tool in most geriatric rehabilitation settings in the Australian health service where dietetic resources are scarce and intervention needs to be prioritised for those already

malnourished. If this tool is selected by a rehabilitation institution or practitioner, perhaps a lower cut-off value to determine risk of malnutrition may be applied in order to identify those who should be prioritised for intervention. Although the MNA-SF did not show predictive validity in this study, a previous study showed that the MNA-SF was able to predict institutionalisation, decreased physical function and decreased quality of life in geriatric rehabilitation (Neumann et al., 2005). Therefore, although the MNA-SF displayed poor criterion validity, it may still be useful in identifying patients in need to nutritional intervention in rehabilitation facilities with a focus on both prevention and treatment of malnutrition. Further benefits and uses of the MNA-SF include its suitability to use a screening tool if the full MNA is used as the nutrition assessment tool, as the MNA-SF forms the first six components of the full MNA (appendix VII).

The MNA-SF is disadvantaged by the need to obtain anthropometric measures such as weight and height and the need to perform calculations (BMI); however, calf circumference may be used if height and weight cannot be obtained (Kaiser et al., 2009). Rehabilitation units which select the MNA-SF as the nutrition screening tool will have to select a second nutrition screening tool for patients <65 years, as the tool is to be applied to geriatric populations only. Furthermore, six-item MNA-SF has a longer implementation time in comparison to short nutrition screening tools such as the MST and the Rapid Screen.

The MST has the benefit of being relatively quick and simple to implement as it consists of two items only, without the need to obtain anthropometric measures or to perform calculations. In addition, it may be applied to adult and geriatric populations. However, the MST does not form part of a nutrition assessment tool. Furthermore, due to the short implementation time, it may increase the risk of social desirability bias, where the patient provides a quick answer without much investigation by the person implementing the tool. Further research using a pragmatic approach where non-dietetic staff complete the screening tools would further explore the application of these screening tools in geriatric rehabilitation.

The predictive validity of the MST and the MNA-SF could not be established in this study. The MST was underpowered to detect a significant difference for all longitudinal outcomes; that is, rehospitalisation LOS, admission to an RACF and discharge location. However, the MNA-SF may have had enough power to predict admission to an RACF and discharge location, however, found no significant difference in these outcomes. This should be considered in the knowledge that nutrition assessment tools such as the ICD-10-AM,

Scored PG-SGA and the full MNA were able to identify a significant difference in these measures in this sample (see chapter 5.3 below). If large samples of participants are required before the MST is able to detect differences in the rates of hospital and aged care use, it is likely that the clinical relevance of the predictive validity is unimportant. In addition, as the MNA-SF may have had adequate power, it is likely that it was not able to detect a difference as a result of overestimating the risk of malnutrition. Therefore, these findings highlight the need for nutrition screening to be followed by a full nutrition assessment, as the screening tools alone are not sufficiently valid to identify all patients with poor malnutrition-related outcomes.

Dissemination of these findings is important, so that a more critical and informed approach may be used when selecting a nutrition screening tool, and so that further research may repeat the study design in other settings for stronger conclusions, such as metropolitan and non-geriatric rehabilitation. The results of this study should be included in any further guidelines for the management of malnutrition, and in reviews of nutrition screening tools.

5.3 Malnutrition in rural geriatric rehabilitation: Prevalence, health-related longitudinal outcomes and the validity of nutrition assessment tools

5.3.1 Introduction

Malnutrition has a high prevalence in geriatric rehabilitation, ranging from 15 – 65% in metropolitan Australia according to the MNA and SGA tools (chapter 2.6.3). There has only been one study which has measured the prevalence of malnutrition in a rural Australian setting, reporting prevalence at 65% according to the SGA (n=20); however, this research was not peer reviewed (Thomas & Mclean, 2014). Health-related longitudinal outcomes such as quality of life, physical function and institutionalisation (admission to an RACF) have been reported post-discharge from rehabilitation in metropolitan areas, but it is unknown if rural dwelling older adults have similar poor outcomes and subsequent need for services (chapter 4.2.2).

Malnutrition is often diagnosed through the use of a nutrition assessment tool (chapter 2.5.2). Both the SGA and MNA (appendix VII) have been evaluated in the geriatric rehabilitation setting. The SGA, developed for a non-geriatric population, was shown to have good reproducibility when compared with blinded physician assessment and longitudinal outcomes in four geriatric rehabilitation units in Canada (Duerksen et al., 2000). The MNA was designed specifically for an older population, and is widely used across health care settings (Watterson et al., 2009). However, although the MNA has been

evaluated in geriatric rehabilitation, only body composition has been used as a benchmark with no evaluation against other nutrition parameters or multidimensional assessments (Neumann et al., 2007). The MNA has been found to have good predictive validity in geriatric rehabilitation when assessed for association with mortality, institutionalisation, physical function and quality of life. The Scored PG-SGA (appendix IX), originally developed for an adult oncology population, is increasing in popularity in a variety of healthcare settings beyond oncology (Bauer et al., 2002; Bauer et al., 2011; Desbrow et al., 2005; Isenring et al., 2003; Martineau et al., 2005), but has not yet been evaluated in any geriatric population nor in a rehabilitation setting.

As described in chapter 5.2.1 above, evaluating the criterion validity is the ideal method to evaluate a nutrition assessment tool as there is no gold standard for diagnosing malnutrition. The ICD-10-AM classification for malnutrition is a useful benchmark to establish the concurrent validity of a nutrition assessment tool. Health-related longitudinal outcomes which are known to be influenced by malnutrition, such as institutionalisation, discharge location, length of stay, rehospitalisation and mortality, provide the opportunity to evaluate the predictive validity of a nutrition assessment tool, as well as to describe the outcomes of malnourished older adults admitted to rehabilitation. Therefore, a study was undertaken in malnourished older adults admitted to rehabilitation, which aimed to: 1) report the prevalence, health and aged care use, and mortality of malnourished older adults; 2) determine and compare the criterion (concurrent and predictive) validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA) in diagnosing malnutrition; and 3) identify the Scored PG-SGA score cut-off value associated with malnutrition. The Scored PG-SGA used in this study was the 2001 version (appendix IX).

5.3.2 Publications

Marshall S, Young A, Bauer J, Isenring E. Malnutrition in geriatric rehabilitation: prevalence, patient outcomes and criterion validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA) *Journal of the Academy of Nutrition and Dietetics*. 2016; 116(5):785-794⁷. *Number of citations by date of thesis submission: 1.*

This study has also been published and presented elsewhere:

⁷ Page numbers of the featured publication correspond with the journal publication and not with this thesis.

- *Published abstract: **Marshall S**, Bauer J, Young A, Isenring E. Nutrition assessment in geriatric rehabilitation: comparing the Scored Patient-Generated Subjective Global Assessment (PG-SGA) with the Mini Nutritional Assessment (MNA) [Abstract]. *Nutrition & Dietetics*. 2014;71(S1):52.*
- *Published abstract: **Marshall S**, Bauer J, Young A, Isenring E. Malnutrition in geriatric rehabilitation: prevalence, patient outcomes and criterion validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA). *Journal of Gastroenterology and Hepatology*. 2015;30(S3):160.*
- *Oral presentation: **Skye Marshall**, Adrienne Young, Judith Bauer, Elizabeth Isenring. Criterion validity of nutrition screening and assessment tools in geriatric rehabilitation. *DAA Qld Branch Professional Development event “3 Minutes to Shine” session, Brisbane, July 2015.**
- *Oral presentation: **Skye Marshall**, Adrienne Young, Judith Bauer, Elizabeth Isenring. Malnutrition in geriatric rehabilitation: prevalence, patient outcomes and criterion validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA). *Winner of Best Oral Presentation at Bond University Faculty of Health Sciences and Medicine Higher Degree Research Conference, Robina, November 2015.**
- *Poster presentation: **Skye Marshall**, Judith Bauer, Adrienne Young, Elizabeth Isenring. Nutrition assessment in geriatric rehabilitation: comparing the Scored Patient-Generated Subjective Global Assessment (PG-SGA) with the Mini Nutritional Assessment (MNA). *Presented at the Dietitian Association of Australia’s National Conference in Brisbane, 2014.**
- *Poster presentation: **Skye Marshall**, Judith Bauer, Adrienne Young, Elizabeth Isenring. Malnutrition in geriatric rehabilitation: prevalence, patient outcomes and criterion validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA). *Presented at AuSPEN / GASTRO2015 Conference in Brisbane, September 2015.**
- *Poster presentation: **Skye Marshall**, Adrienne Young, Judith Bauer, Elizabeth Isenring. Malnutrition in geriatric rehabilitation: prevalence, patient outcomes and criterion validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA). *Presented at Bond**

*University Faculty of Health Sciences and Medicine Higher Degree Research
Conference, Robina, November 2015.*



Malnutrition in Geriatric Rehabilitation: Prevalence, Patient Outcomes, and Criterion Validity of the Scored Patient-Generated Subjective Global Assessment and the Mini Nutritional Assessment



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ABSTRACT

Background Accurate identification and management of malnutrition is essential so that patient outcomes can be improved and resources used efficaciously.

Objectives In malnourished older adults admitted to rehabilitation: 1) report the prevalence, health and aged care use, and mortality of malnourished older adults; 2) determine and compare the criterion (concurrent and predictive) validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA) in diagnosing malnutrition; and 3) identify the Scored PG-SGA score cut-off value associated with malnutrition.

Design Observational, prospective cohort.

Participants/setting Participants were 57 older adults (65 years and older; mean \pm standard deviation age = 79.1 ± 7.3 years) from two rural rehabilitation units in New South Wales, Australia.

Measurements/statistical analysis Scored PG-SGA; MNA; and the *International Statistical Classification of Diseases and Health Related Problems, 10th revision, Australian Modification* (ICD-10-AM) classification of malnutrition were compared to establish concurrent validity and report malnutrition prevalence. Length of stay, discharge location, rehospitalization, admission to a residential aged care facility, and mortality were measured to report health-related outcomes and to establish predictive validity.

Results Malnutrition prevalence varied according to assessment tool (ICD-10-AM: 46%; Scored PG-SGA: 53%; MNA: 28%). Using the ICD-10-AM as the reference standard, the Scored PG-SGA ratings (sensitivity 100%, specificity 87%) and score (sensitivity 92%, specificity 84%, ROC AUC [receiver operating characteristics area under the curve] = 0.910 ± 0.038) showed strong concurrent validity, and the MNA had moderate concurrent validity (sensitivity 58%, specificity 97%, receiver operating characteristics area under the curve = 0.854 ± 0.052). The Scored PG-SGA rating, Scored PG-SGA score, and MNA showed good predictive validity. Malnutrition can increase the risk of longer rehospitalization length of stay, admission to a residential aged care facility, and discharge to hospital or residential aged care facility instead of home.

Conclusions Malnutrition prevalence in the geriatric rural rehabilitation population is high, and is associated with increased health and aged care use. The Scored PG-SGA ratings and score are suitable for nutrition assessment in geriatric rehabilitation. The MNA may be suitable for nutrition assessment in geriatric rehabilitation, but care should be taken to ensure all malnourished patients are identified. Additional examination of the criterion validity of the Scored PG-SGA and MNA will lend confidence to these findings. *J Acad Nutr Diet.* 2016;116:785-794.

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THE PHYSIOLOGICAL AND PSYCHOSOCIAL CONSEQUENCES of malnutrition are significant and diverse. In health care facilities, malnutrition increases morbidity, mortality, and incidence of complications. Overall, this leads to increased treatment costs and length of stay.^{1,2} Common symptoms of malnutrition, such as confusion, fatigue,

and weakness, are often attributed to other conditions, leading to frequent misdiagnosis and under-recognition of malnutrition.³ There is strong evidence showing malnutrition is under-recognized and under-diagnosed in the rehabilitation setting, despite a high prevalence (30% to 50%).⁴ In addition, the prevalence of malnutrition in rural rehabilitation facilities, as opposed to metropolitan facilities, has not been reported.⁴

Accurate identification, management, and monitoring of malnutrition are essential steps in the nutrition care process so that patient outcomes can be improved and resources used efficaciously.⁵ Nutrition assessment is often completed through the application of a nutrition assessment tool. Unlike nutrition screening tools, nutrition assessment tools can be used to make a diagnosis of malnutrition by medical staff or a registered dietitian nutritionist.⁶ However, the tool chosen should be validated for the population to which it is applied. In the rehabilitation setting, there are only two nutrition assessment tools that have been evaluated for validity. These include the Subjective Global Assessment (SGA) and the Mini Nutritional Assessment (MNA).⁴ The MNA was designed specifically for an older population, and is perhaps the most widely reported nutrition assessment tool in the literature across health care settings^{4,7,8}; however, both the MNA and SGA lack sensitivity to show changes in nutrition status during a short period of time, such as during hospital and rehabilitation admissions.⁹ The Scored Patient-Generated SGA (PG-SGA) was adapted from the SGA and includes seven components for assessment: weight, food intake, nutrition impact symptoms, activities and function, medical condition, metabolic stress, and physical examination.⁹ The questions regarding short-term weight loss and nutrition impact symptoms increase the Scored PG-SGA's sensitivity to changes in nutrition status over a short period of time.^{9,10} The Scored PG-SGA provides a global rating of nutrition status for a nutritional diagnosis as well as a continuous numerical score for intervention triage.^{11,12} Since its development, the Scored PG-SGA has shown to be appropriate for use in oncology, acute medical, renal, stroke, neurology, and respiratory patients, as well as the residential aged care setting.¹³⁻¹⁸ The Scored PG-SGA has not been evaluated in the rehabilitation setting or older adult population. Therefore, in the older adult rural rehabilitation population, the aims of this study were to report the prevalence, health, aged care use, and mortality of malnourished older adults; determine and compare the criterion (concurrent and predictive) validity of the Scored PG-SGA and the MNA in diagnosing malnutrition; and identify the Scored PG-SGA score cut-off value associated with malnutrition.

MATERIALS AND METHODS

Study Sample

Participants consecutively admitted to one of two public rehabilitation units in rural¹⁹ New South Wales, Australia, were approached to participate if they were English-speaking inpatients 65 years or older, lived in the community before admission, and had an informal caregiver. Patients were only included if they were admitted with the expectation they would return to their own homes upon discharge. This study was conducted between August 2013 and February 2014 as part of the MARRC (Malnutrition in the Australian Rural

Rehabilitation Community) Study (Trial version 2.0, 9 May 2013) which has been registered at the Australian New Zealand Clinical Trials Registry (ACTRN12613000518763) and has received ethical and governance approval (North Coast NSW Human Research Ethics Committee: LNR 063, G108; School of Human Movement Studies Ethics Committee: HMS13/0731). Written informed consent was obtained from all participants and/or their guardians.

Data Collection

Outcome measurement tools, including all components of the Scored PG-SGA, were completed on behalf of the participant by the primary researcher (a trained accredited practising dietitian [Australian-certified]) and were informed by interview with the patient, their caregivers, rehabilitation staff, and consultation of medical notes.

Nutrition Assessment

Nutrition assessment using both the Scored PG-SGA and MNA was conducted by the primary researcher within a median of 2 days after admission. A higher Scored PG-SGA score indicates an increased risk for malnutrition.⁹ The Scored PG-SGA also provides global ratings of well-nourished (rated A), moderately or suspected of being malnourished (rated B), or severely malnourished (rated C), which are analogous to the SGA ratings.¹¹ For this study, an increase or decrease of ≥ 0.5 kg within 2 weeks was considered a change in weight, any nutrition impact symptoms present within the previous 2 weeks were included, and functional impairment was considered only where it was related to nutrition status. The MNA is scored 0 to 30, where a score of < 17 indicates malnourished, 17 to 23.5 indicates at risk of malnutrition, and 24 to 30 indicates normal nutrition status.⁸

The *International Statistical Classification of Diseases and Health Related Problems, 10th revision, Australian Modification* (6th ed [ICD-10-AM])²⁰ criteria are the recognized standard diagnostic criteria in Australia for the diagnosis, documentation, and diagnostic related group coding of protein-energy malnutrition (or malnutrition) (Figure 1). The ICD-10-AM classification is determined using body mass index (BMI; calculated as kg/m^2), weight history, dietary intake, and a physical assessment of fat and/or muscle wasting. These criteria are used in Australian hospitals to provide case-mix funding reimbursements, and failure to identify and document malnutrition in the health care setting can have significant detrimental impacts upon funding.²¹ Therefore, the nutrition assessment method used must be in agreement with the ICD-10-AM criteria to ensure that resources are available for treatment. As there is no gold standard for diagnosing malnutrition, the criterion validity (ie, the concurrent and predictive validity) of a diagnostic tool must be established. In this study, the ICD-10-AM classification was used as the reference standard for malnutrition, as it is the agreed upon standard in the Australian health care setting, and has recently been used as the standard against which nutritional screening and assessment tools have been validated.^{22,23} The Scored PG-SGA components of current weight, height, 1- or 6-month weight loss and assessment of fat stores and muscle status were used to inform the ICD-10-AM classification of malnutrition for each participant. Weight (kg) was measured by the primary researcher using Tanita

Classification	Definition
E43: Unspecified severe protein-energy malnutrition	In adults, BMI ^a <18.5 or unintentional loss of weight ($\geq 10\%$) with evidence of suboptimal intake resulting in severe loss of subcutaneous fat and/or severe muscle wasting.
E44.0: Moderate protein-energy malnutrition	In adults, BMI <18.5 or unintentional loss of weight (5% to 9%) with evidence of suboptimal intake resulting in moderate loss of subcutaneous fat and/or moderate muscle wasting.
E44.1: Mild protein-energy malnutrition	In adults, BMI <18.5 or unintentional loss of weight (5% to 9%) with evidence of suboptimal intake resulting in mild loss of subcutaneous fat and/or mild muscle wasting.

^aBMI, body mass index; calculated as kg/m².

Figure 1. The *International Statistical Classification of Diseases and Health Related Problems, 10th Revision, Australian Modification* (6th ed, ICD-10-AM) classifications for protein-energy malnutrition in adults.²⁰

InnerScan Body Composition Monitor scales (model BC-541; Tanita Corporation) or rehabilitation wards scales (chair or roll-on scales) for nonweight-bearing participants. All three scales were within 0.1 kg calibration. Weights recorded for amputees were adjusted.²⁴ Estimated height was calculated using knee height.²⁴

Health and Aged Care Service Use

A range of variables was chosen to represent rehabilitation outcome, health service use, and patient well-being. These included discharge location (ie, home/other: hospital, residential aged care facility, or friend/family) and rehabilitation length of stay (days) upon discharge; and rehospitalization incidence (number of acute care and rehabilitation readmissions), rehospitalization length of stay (total days of all subsequent rehabilitation and acute admissions), admission to a residential aged care facility (yes/no), and death (yes/no) at 12 weeks post discharge. Data were obtained from the health service's electronic admissions database and confirmed by telephone or in-home interviews.

Statistical Approach

All statistical analysis was completed using SPSS software (version 22.0, 2013, IBM SPSS Statistics for Windows). Significance was considered at the $P < 0.05$ level. Descriptive statistics were used to characterize the sample population and prevalence of malnutrition. The χ^2 goodness-of-fit tests were used to test for a significant difference in nutrition status categories according to each nutrition assessment method. For examination of the criterion validity and to report prevalence, nutrition status was considered as binary variables, and therefore collapsed into well-nourished and malnourished for each tool and the diagnostic criteria. Only patients with existing malnutrition and not risk of malnutrition were considered malnourished, in order to evaluate a tool's ability to diagnose existing malnutrition. Therefore, malnourished ratings were given for Scored PG-SGA ratings of B and C, MNA score < 17 and any participant meeting the ICD-10-AM criteria of E43 (severe malnutrition), E44.0 (moderate malnutrition), or E44.1 (mild malnutrition) (as per Figure 1). In addition, a cut-off value to identify malnourished geriatric patients for the Scored PG-SGA score was determined using a receiver operating characteristics (ROC) curve using the Scored PG-SGA ratings as the standard. Sensitivity and specificity were considered equally important in

determining the cut-off value. All other ratings/scores were classified as well-nourished.

To determine the concurrent validity of the Scored PG-SGA and MNA, the sensitivity, specificity, positive predictive value, negative predictive value, diagnostic odds ratio (DOR),²⁵ weighted κ -statistic,²⁶ and their 95% CIs were determined using contingency tables against the ICD-10-AM classification of malnutrition. The Scored PG-SGA and MNA scores were further assessed as continuous variables for concurrent validity against the ICD-10-AM classification of malnutrition using an ROC curve. An ROC curve provides an assessment on the discriminative power of a test, where an ROC area under the curve (AUC) of 0.9 to 1.0 is considered an excellent test, 0.8 to 0.9 a very good test, 0.7 to 0.8 a good test, 0.6 to 0.7 a sufficient test without much value in the clinical setting, 0.5 to 0.6 a bad test and < 0.5 of no use.²⁵

Any longitudinal outcome with results significantly different between the well-nourished and malnourished groups according to the ICD-10-AM criteria was used to evaluate the predictive validity of the Scored PG-SGA and MNA using the Mann-Whitney U test and χ^2 test. Participants who did not have any readmissions were excluded from the rehospitalization length of stay analysis.

RESULTS

Study Participants

Over the study recruitment period, 57 consecutive rehabilitation inpatients consented to participate in the study (response rate of 98%). The sample was 49% female, with a mean \pm standard deviation age of 79.1 \pm 7.3 years; however, there was a significant difference in age between sites (77.5 years vs 81.4 years). The study sample is further described elsewhere.²⁷

Nutrition Status and Health-Related Patient Outcomes

Malnutrition prevalence varied according to nutrition assessment method, where the ICD-10-AM criteria determined 46% were malnourished, the Scored PG-SGA ratings determined 53% were malnourished, and the MNA determined 28% were malnourished with a further 58% at risk of malnutrition (Table 1). The median Scored PG-SGA score was 7.0 (interquartile range=3 to 11.5). Rehabilitation length of stay excluded three participants who had emergency

Table 1. Nutrition status of 57 older adults admitted to rehabilitation units in rural New South Wales, Australia, as assessed by the ICD-10-AM^a classification of protein-energy malnutrition, Scored Patient-Generated Subjective Global Assessment and Mini Nutritional Assessment overall and by facility

	ICD-10-AM Classification of PEM ^b			
	Well-nourished	E44.1: Mild PEM	E44.0: Moderate PEM	E43: Unspecified severe PEM
	n (%)			
Both sites (n=57)	31 (54.4)	4 (7.0)	16 (28.1)	6 (10.5)***
Site A (n=33)	19 (57.6)	2 (6.1)	6 (18.2)	5 (15.2)***
Site B (n=24)	12 (50.0)	3 (12.5)	8 (33.3)	1 (4.2) [†]
	Scored PG-SGA ^c			
	Well-nourished (rated A)	Moderate or suspected malnutrition (rated B)	Severely malnourished (rated C)	
	n (%)			
Both sites (n=57)	27 (47.4)	15 (26.3)	15 (26.3)	
Site A (n=33)	19 (57.6)	8 (24.2)	6 (18.2)	
Site B (n=24)	8 (33.3)	7 (29.2)	9 (37.5)	
	MNA ^d			
	Normal nutrition status (scored 24 to 30)	Risk of malnutrition (scored 17 to 23.5)	Malnourished (scored 0 to 16)	
	n (%)			
Both sites (n=57)	8 (14.0)	33 (57.9)	16 (28.1)	
Site A (n=33)	6 (18.2)	22 (66.7)	5 (15.2)*	
Site B (n=24)	2 (8.3)	11 (45.8)	11 (45.8)*	

^aICD-10-AM=International Statistical Classification of Diseases and Health Related Problems 10th Revision Australian Modification (6th ed).²⁰

^bPEM=protein energy malnutrition.

^cPG-SGA=Patient-Generated Subjective Global Assessment.

^dMNA=Mini Nutritional Assessment.

*Significant difference between rehabilitation centers ($P<0.05$).

***Significant difference across nutrition status categories ($P<0.001$).

[†]Significant difference across nutrition status categories ($P=0.002$).

admissions to acute care. According to the ICD-10-AM classification of malnutrition, malnourished participants had a significantly longer cumulative length of stay for all rehabilitation and acute readmissions within 12 weeks ($P=0.032$) (Table 2). Malnourished patients also had a higher incidence of admission to a residential aged care facility within 12 weeks ($P=0.052$) and a lower incidence of discharge to home, as more were discharged to hospital, residential aged care facility, or to stay with family or friends ($P=0.052$). Three malnourished participants died after discharge from rehabilitation; there were no deaths in the well-nourished group.

Scored PG-SGA Score to Indicate Malnutrition

The sensitivity and specificity for coordinates of the curve (cut-off values) were provided for the average of two test values (Scored PG-SGA scores, which are whole numbers), where 7.5 had the strongest overall sensitivity (90%) and specificity (96.3%). A value of 6.5 had a sensitivity of 90% and specificity of 92.6% and a value of 8.5 had sensitivity of 80%

and specificity of 100%. A cut-off of 6 (represented by coordinate 6.5) was considered not to have a strong enough specificity, and a cut-off of 8 (represented by coordinate 8.5) was considered to have too low a sensitivity, compared with a cut-off value of 7 (represented by coordinate 7.5). Therefore, a cut-off value of 7 was considered the most appropriate score to indicate the need for critical intervention in older adult medical patients and was used to classify patients as malnourished for the Scored PG-SGA score.

Concurrent and Predictive Validity of the Scored PG-SGA and MNA Tools

Results of the contingency table analysis for Scored PG-SGA ratings, Scored PG-SGA score, and MNA against the ICD-10-AM criteria and their predictive validity are presented in Table 3. The Scored PG-SGA ratings showed strong diagnostic accuracy, with perfect sensitivity, good specificity, and "almost perfect" agreement.²⁶ In addition, the Scored PG-SGA ratings had the strongest association with re-hospitalization and admission to a residential aged care

Table 2. Health and aged care use of a sample of 57 older adults admitted to rehabilitation units in rural New South Wales, Australia, by nutrition status and in total according to the ICD-10-AM^a classification of protein energy malnutrition

Variable	Well-nourished (n=31)	Malnourished (n=26)	Total participants (n=57)
	← median (interquartile range) →		
Rehabilitation LOS ^b (days)	23.0 (16.0 to 37.5)	22.0 (13.75 to 32.75)	23.0 (14.0 to 33.5)
Rehospitalization LOS (days) ^c	4.0 (1.0 to 14.75)	10.0 (7.0 to 36.0)	8.0 (2.0 to 28.0) [†]
Rehospitalization incidence			
Median (interquartile range)	2.0 (1.0 to 2.0)	1.0 (1.0 to 2.0)	1.0 (1.0 to 2.0)
n (%)	12 (38.7)	11 (38.5)	23 (40.4)
	← n (%) →		
Discharge location			
Home	27 (87.1)	17 (65.4)	44 (77) [‡]
Other ^d	4 (12.9)	9 (34.6)	13 (23)
Admitted to RACF ^e	4 (12.9)	7 (26.9)	11 (19.3)
Mortality	0	3 (11.5)	3 (5.3) [‡]

^aInternational Statistical Classification of Diseases and Health Related Problems 10th Revision Australian Modification (6th ed).²⁰^bLOS=length of stay.^cParticipants with no rehospitalization excluded from analysis.^dCommunity-dwelling participants discharged to a hospital, a residential aged care facility, or to stay with family/friends.^eRACF=residential aged care facility.[†]Significant difference between nutrition status ($P=0.032$).[‡]Approaching significant difference between nutrition status ($P=0.052$).

facility. Using a cut-off of 7, the Scored PG-SGA score showed strong sensitivity and specificity, and had substantial agreement; however, the score was not able to predict admission to a residential aged care facility. The ROC AUC for the Scored PG-SGA score against ICD-10-AM classification indicated the Scored PG-SGA score has excellent discriminative power to detect malnutrition (Figure 2). The MNA showed good predictive validity; however, the sensitivity and specificity were moderate, and it had the lowest agreement ($\kappa=0.562$; 95% CI 0.303 to 0.631, indicating moderate agreement²⁶). The MNA score's ROC AUC was considered to be a very good test²⁵ (Figure 3). The ROC analysis of the MNA score against the ICD-10-AM criteria also provided the sensitivity and specificity for coordinates of the curve (data not shown). A value of 19 provided the strongest results with sensitivity (83.3%) and specificity (74.4%) compared with current cut-off of 17 (sensitivity 57.7%, specificity 96.8%) (Figure 3). The large 95% CIs of the DOR for each of the nutrition assessment tools shows the DOR is not adequately powered by the current sample size and is of little value.

DISCUSSION

The nutrition assessment results in this sample indicate that older adults admitted to rural rehabilitation facilities have a high prevalence of malnutrition (46% according to the ICD-10-AM criteria), which is associated with increased health and aged care utilization. This is the first study investigating malnutrition prevalence in a rural rehabilitation population, and results suggest the prevalence is comparable to that reported in metropolitan areas of Australia. Three Australian metropolitan studies reported prevalences

of 6%, 29%, and 30%^{31–33} (using MNA score <17 for malnourished) compared to 28% in the current rural sample. A fourth Australian metropolitan study reported a malnutrition prevalence of 49% using the SGA (B and C ratings indicating malnutrition)³⁴ compared to 53% in the current sample indicated by the analogous Scored PG-SGA ratings. According to the MNA, Asia has a lower prevalence at 14% to 17%,^{35,36} and Europe has a higher prevalence at 33% to 53%.^{37,38} According to the SGA, Europe has a slightly lower prevalence of malnutrition (32% to 46%).^{39,40} All international prevalences were reported in metropolitan geriatric rehabilitation populations. No studies were identified reporting the malnutrition prevalence in geriatric rehabilitation in North America, South America, or Africa. The Scored PG-SGA ratings considered 15 participants to be severely malnourished (rating C); however, the ICD-10-AM only considered six were severely malnourished due to differences in time frames of weight loss and the severity of muscle wasting required by each assessment method. The MNA does not categorize patients by severity of malnutrition, but reported similar numbers of patients as malnourished, which the Scored PG-SGA ratings considered severely malnourished.

The Scored PG-SGA score and ratings performed consistently well when compared to the ICD-10-AM classification of protein-energy malnutrition. This is the first study evaluating the diagnostic validity of the Scored PG-SGA in the rehabilitation setting. It is also the first study to evaluate a cut-off value for the Scored PG-SGA score to indicate malnutrition in older patients, as the score was derived previously for an adult medical sample only.¹¹ The Scored PG-SGA has not previously been evaluated for validity in a geriatric population. Previous studies evaluating the Scored

Table 3. Measures of diagnostic accuracy of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and Mini Nutritional Assessment (MNA) against the ICD-10-AM^a classification of protein-energy malnutrition in a sample of 57 older adult rural rehabilitation inpatients

	κ -Statistic	Sensitivity	Specificity	PPV ^b	NPV ^c	DOR ^d	Rehospitalization LOS ^e	Admission to RACF ^f	Discharge location
		%					P value		
Scored PG-SGA ratings							0.005 ^h	0.008 ⁱ	0.046 ^j
Value	0.860 [†]	100	87.1	86.7	100	323.9 ^g			
95% CI	0.639 to 0.860	87.1 to 100	71.2 to 94.9	69.3 to 96.2	87.1 to 100	16.6 to 6313.6			
Scored PG-SGA score							0.03 ^h	0.107 ⁱ	0.033 ^j
Value	0.755 [†]	92.3	83.9	82.8	92.9	62.4			
95% CI	0.499 to 0.869	75.9 to 97.9	67.4 to 92.9	64.2 to 94.1	76.5 to 98.9	11.2 to 352.4			
MNA							0.023 ^h	0.034 ⁱ	0.019 ^j
Value	0.562 [§]	57.7	96.8	93.8	73.2	40.9			
95% CI	0.303 to 0.631	39.0 to 74.5	83.8 to 99.4	69.7 to 99.0	57.1 to 85.8	4.8 to 347.3			

^aInternational Statistical Classification of Diseases and Health Related Problems 10th Revision Australian Modification (9th ed).²⁰^bPPV=positive predictive value.^cNPV=negative predictive value.^dDOR=diagnostic odds ratio.^eLOS=length of stay.^fRACF=residential aged care facility.^gThe false-negative values for the PG-SGA-rating compared with the ICD-10-AM criteria were 0. However, due to the problems with computation of odds ratios with a 0 value, each cell in the contingency table had 0.5 added.²⁹⁻³⁰^h χ^2 test.ⁱMann-Whitney U test.^j $P<0.0001$, "almost perfect agreement" as per Landis and Koch κ -statistic classification.²⁶[†] $P<0.0001$, "substantial agreement" as per Landis and Koch κ -statistic classification.²⁶[§] $P<0.0001$, "moderate agreement" as per Landis and Koch κ -statistic classification.²⁶

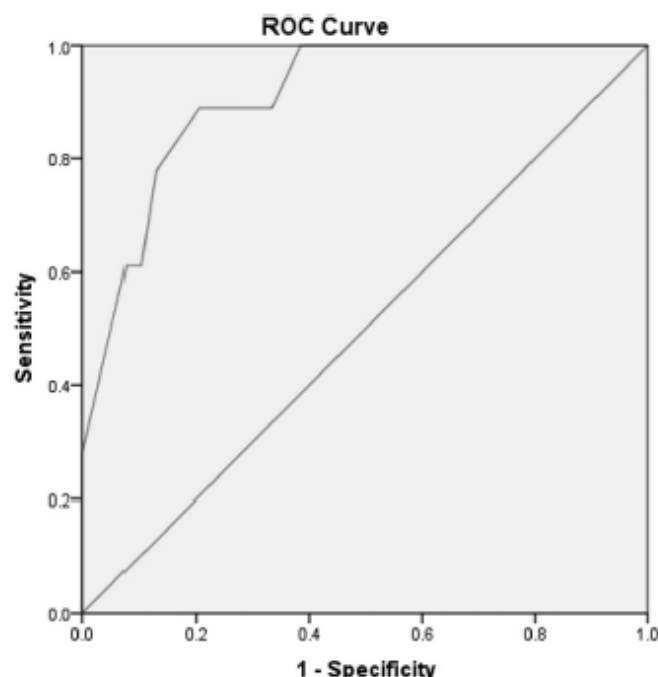


Figure 2. Receiver operating characteristics (ROC) curve plot of the true positive (sensitivity) rate against the false positive (1-specificity) rate at various cut-off values of the Scored Patient-Generated Subjective Global Assessment score compared with the *International Statistical Classification of Diseases and Health Related Problems, 10th revision, Australian Modification*,²⁰ classification of malnutrition. The area under the curve (AUC) of 0.910 ± 0.038 ($P < 0.0001$; 95% CI 0.836 to 0.983) with a nonparametric assumption indicates an “excellent test.”²⁵

PG-SGA ratings have established concurrent validity using clinical outcomes, such as BMI, physical function, serum albumin, and oxygen saturation as the benchmark, and the predictive validity using length of stay and rate of complications.¹⁵⁻¹⁷ The comparison of the Scored PG-SGA to comprehensive criteria, such as the ICD-10-AM classification of protein-energy malnutrition, lends strength to the current study, showing that the tool will accurately reflect diagnostic and funding criteria used throughout the health care system.

Although the MNA had a strong specificity and positive predictive value, the sensitivity could be considered poor for a diagnostic assessment tool. A previous validation study found significantly higher sensitivity (96%) of the MNA than that reported in this study when compared with physician assessment of malnutrition⁷; however, this was in an acute and community population. Neumann and colleagues⁴¹ evaluated the MNA in a geriatric rehabilitation population against body composition, and found that the AUC was 0.74, which was lower than the current study (AUC=0.85) and the ideal cut-off value was 22.3, a much higher value than the 19 found in this study.

The MNA sensitivity could be improved by using the cut-off value of <24 to indicate malnutrition as reported in previous studies^{31,32,41-43}; however, a score of 17 to 24 indicates patients at risk of malnutrition and would lead to the MNA overestimating malnutrition prevalence (86% in this study). Inappropriate diagnosis is clinically significant due to the

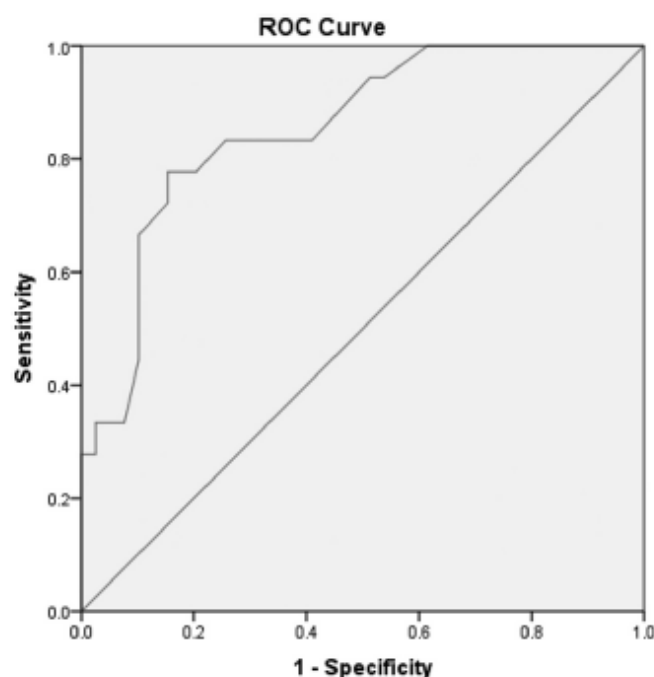


Figure 3. Receiver operating characteristics (ROC) curve plot of the true positive (sensitivity) rate against the false positive (1-specificity) rate at various cut-off values of the Mini Nutritional Assessment score compared with the *International Statistical Classification of Diseases and Health Related Problems, 10th revision, Australian Modification*,²⁰ classification of malnutrition. The area under the curve (AUC) of 0.854 ± 0.052 ($P < 0.0001$; 95% CI 0.752 to 0.956) with a nonparametric assumption indicates a “very good test.”²⁵

time and resource restraints of health care facilities to provide nutrition support; therefore, the purpose of the nutrition assessment tool should be considered. It has been suggested previously that the MNA may be more suited to an environment focused on prevention, where a score of <24 is used to identify all patients at risk and already malnourished, as opposed to accurately identifying existing malnutrition (using a score of <17) for intervention.⁴⁴⁻⁴⁶ Although risk of malnutrition, according to the MNA (scored 17 to 23.5), is associated with poor patient outcomes in an older rehabilitation population, including increased risk of institutionalization and rehospitalization and decreased physical function and quality of life,^{31,33} this study suggests the category of malnourished (score of <17) closer reflects the ICD-10-AM for diagnosing malnutrition in geriatric rehabilitation than using a score <24 .

This study indicates the Scored PG-SGA and MNA have good predictive validity with regard to discharge location, rehospitalization, and admission to a residential aged care facility within 12 weeks of discharge from rehabilitation. This sample had no difference in rehabilitation length of stay or readmission incidence between well-nourished and malnourished groups. There were three deaths in the malnourished group compared to none in the well-nourished group. It is likely the sample size was not powerful enough to detect a significant difference in this trend in mortality, as seen in larger studies.³³ Overall, these outcomes suggest that rural older rehabilitation patients are

likely to have a high need for medical and aged care services, which may increase health care costs and impact on quality of life.

IMPLICATIONS FOR FUTURE RESEARCH AND CLINICAL APPLICATION

The high prevalence of malnutrition in the rural geriatric rehabilitation population is a major challenge for patients, informal caregivers, and health care providers. Although the prevalence of malnutrition in rural communities is similar to that in metropolitan areas, there is decreased availability of health and aged care services.^{2,47} It is therefore critical that these patients are accurately identified and engaged with nutrition support during both rehabilitation and post discharge. This study suggests that the Scored PG-SGA ratings or a score of ≥ 7 can be used to accurately identify malnourished older adults in rehabilitation and can be used to triage patients. Future research regarding the validity of the Scored PG-SGA should repeat an evaluation of the criterion validity in a larger and diverse geriatric sample and should include an evaluation of inter-rater reliability in rehabilitation. This would strengthen the results of the current study and lend more confidence to selecting the appropriate cut-off value to indicate malnutrition and triage of older inpatients in general. A direct comparison of the Scored PG-SGA and the MNA would also be of interest.

Regarding the MNA, results suggest that practitioners need to be careful to identify all malnourished older adults in rehabilitation if using the standard MNA criteria (score of <17) as malnourished patients may be labeled as at risk of malnutrition. Future research should evaluate whether the scoring criteria for the MNA categories should be adjusted to include a higher cut-off value to indicate patients who are malnourished in geriatric rehabilitation.

Limitations

A limitation of using the ICD-10-AM classification of malnutrition as the standard in this population is the BMI cut-off of <18.5 , which is likely to be too low for an older population.^{48,49} This may have caused a decrease in the sensitivity of the nutrition assessment tools when compared to the ICD-10-AM classifications. While the Scored PG-SGA has shown to be useful in a variety of settings, its use is somewhat limited by the need for health care providers to receive training in its correct application to ensure inter-rater reliability due to a more complicated scoring and rating system compared to the MNA.

Although the sample size in this study was relatively small, it is unlikely to be affected by nonresponse bias and was powerful enough to detect differences in longitudinal health-related outcomes. The potential bias introduced by having a single researcher completing the assessments was minimized in this study using objective standardized scoring systems and having a second researcher check scores and ratings in a subsample of patients.

CONCLUSIONS

The prevalence of malnutrition in the geriatric rural rehabilitation population is high, and is associated with increased use of health and aged care. This study suggests the Scored PG-SGA ratings and a cut-off value of ≥ 7 have



PRACTICE IMPLICATIONS

What Is the Current Knowledge on this Topic?

The prevalence and health-related outcomes of older adults in rural rehabilitation units are unknown. Regarding nutrition assessment tools, there is a need for evidence of the criterion validity of the Scored PG-SGA and MNA.

How Does this Research Add to Knowledge on this Topic?

In geriatric rehabilitation, this is the first study to report rural malnutrition prevalence and health-related outcomes, assess the criterion validity of Scored PG-SGA, evaluate a cut-off value for the Scored PG-SGA, and evaluate the MNA compared to a multidimensional benchmark.

How Might this Knowledge Impact Current Dietetics Practice?

Outcomes may be used for health care policy development and review of resource allocation. Use of the scored PG-SGA in the geriatric rehabilitation setting is supported, and use of the MNA may be suitable for well-resourced facilities.

strong concurrent and predictive validity in assessing malnutrition in the geriatric rehabilitation setting. The MNA showed good predictive validity but moderate concurrent validity, as the MNA might not identify all malnourished patients, as some may be labeled as at risk of malnutrition. Further examination of the criterion validity of the Scored PG-SGA and MNA will lend confidence to these findings.

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5.3.3 Statement of contribution to publication by authors

Skye Marshall carried out the data collection, conducted the statistical analysis and interpretation of data, and drafted and revised the manuscript. Elizabeth Isenring contributed to data checking. Judith Bauer, Adrienne Young and Elizabeth Isenring provided supervision, guidance and revision of the manuscript.

5.3.4 Long-term mortality outcomes

5.3.4.1 Background

Malnutrition has been associated with increased risk of mortality in the rehabilitation setting (Charlton et al., 2012). In the current sample (n=57) of older adults (≥ 65 years) admitted to two rehabilitation facilities in rural NSW, there were three deaths in the malnourished group and no deaths in the well-nourished group ($P=0.052$). Subsequent to the results of this study being published, six and 12 month mortality data for the participants became available.

The aim of this study was to determine if there was a significant difference in the prevalence of mortality between well-nourished and malnourished older rehabilitation patients at six and 12 months post-discharge.

5.3.4.2 Ethical consideration

This study was conducted between August 2013 and April 2015 as part of the MARRC (Malnutrition in the Australian Rural Rehabilitation Community) Study (trial version 2.0, 9 May 2013) which has been registered at the Australian New Zealand Clinical Trials Registry (ACTRN12613000518763) and has received ethical and governance approval (North Coast NSW Human Research Ethics Committee: LNR 063, G108; School of Human Movement Studies Ethics Committee: HMS13/0731). Written informed consent was obtained from all participants and/or their guardians, however a waiver of consent was granted for the obtainment of mortality data from the NSW Registry of Births, Deaths and Marriages.

5.3.4.3 Data collection

Nutrition assessment was completed by the primary researcher (Accredited Practising Dietitian) and was informed by interview with the patient, their caregivers, rehabilitation staff and consultation of medical notes. A patient was considered 'malnourished' if they met the ICD-10-AM criteria of E43 (severe malnutrition), E44.0 (moderate malnutrition) or E44.1 (mild malnutrition) (2008). Mortality data was obtained from the NSW Registry of Births, Deaths and Marriages; deaths outside NSW were not considered as a death in

this study as it was not feasible to collect these data from all state registries. Death was considered at six months post-discharge from rehabilitation (yes/no) and 12 months post-discharge from rehabilitation (yes/no).

5.3.4.4 Statistical approach

All statistical analysis was completed using SPSS Version 22.0 2013 [IBM SPSS Statistics for Windows. Armonk, NY: IBM Corp.]. To determine if the number of participants who had died was significantly different between the well-nourished and malnourished group according to the ICD-10-AM criteria, the chi-square test was applied. Significance was considered at $P < 0.05$.

5.3.4.5 Results and discussion

Participants' characteristics, outcomes and prevalence of malnutrition are described in the previous publication (Marshall et al., 2016a). At six months post-discharge from rehabilitation, one participant had died in the well-nourished group and four had died in the malnourished group. At 12 months post-discharge from rehabilitation, three participants had died in the well-nourished group and four had died in the malnourished group. There was no significant difference in the prevalence of mortality between well-nourished and malnourished participants at six or 12 months post-discharge.

Although the trend towards an increased mortality rate in the malnourished group seen at three months post-discharge appears to have continued at six months, there is no trend present at 12 months post-discharge. This aligns with previous findings, where only large studies have found significantly increased risk of mortality in malnourished older adults (Marshall et al., 2014).

5.3.5 Conclusion and implication of findings

This study aimed to: 1) report the prevalence, health and aged care use, and mortality of malnourished older adults; 2) determine and compare the criterion (concurrent and predictive) validity of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) and the Mini Nutritional Assessment (MNA) in diagnosing malnutrition; and 3) identify the Scored PG-SGA score cut-off value associated with malnutrition. By addressing these research questions, this study presented many novel findings in the geriatric rehabilitation population. The high prevalence of malnutrition in rural rehabilitation and its association with increased health and aged care utilisation following discharge is important for health care policy development and for review of resource allocation for the nutritional management of rehabilitation patients. The poor outcomes of

the malnourished older adults may have been influenced by the minimal dietetic services available to patients both during and post-rehabilitation. The sampled rehabilitation units each had approximately 0.15 full time equivalent (FTE; 6 hours) per week of dietetic services, significantly less than the minimum of 1.0 and 1.25 FTE for units with 24 and 31 beds (minimum standard 0.4-0.5FTE dietitian per 10 patients) (2011h). Furthermore, no dietetic services were utilised by patients for at the first 12 weeks in the community. Participants included had informal caregivers to assist with activities of daily living once in the community; however, the caregivers were not engaged by nutrition and dietetic services. The services provided to the participants in this study should be considered when generalising results to other populations; however, the understaffing of dietetics to rehabilitation units is a problem across many rehabilitation units in Australia (Barrett et al., 2015)

This study found that the Scored PG-SGA is appropriate for older inpatients as well as the rehabilitation setting; however, the score cut-off value may need to be lower in a geriatric population than an adult medical or oncology population. Further examination of the cut-off value in older medical inpatients, both in acute care or rehabilitation will provide increased confidence in establishing a triage protocol for this age group. The use of the Scored PG-SGA in rehabilitation has increased benefits compared to the SGA in that the score may have increased sensitivity to changes in nutrition status during admission due to the numbered scale as opposed to global ratings alone. However, the Scored PG-SGA does have an increased time of implementation compared to the SGA, and the needs of the practitioner and the rehabilitation unit will determine which tool may be the most appropriate.

Although the MNA has been evaluated in the rehabilitation setting previously, this is the first study to compare the diagnostic accuracy of the MNA to a multidimensional benchmark (the ICD-10-AM) which is an accepted method of diagnosing malnutrition. This study suggests the cut-off value of 17 recommended on the tool may not identify all malnourished patients in the Australian geriatric rehabilitation setting. Conversely, using the popular alternative score of <24 to identify patients at risk of malnutrition may overestimate malnutrition, and have significant detrimental impacts upon resource utilisation. However, when using a score of <24, the MNA may be suited to a well-resourced rehabilitation centre focused on prevention. Although the MNA is not designed to be used in a non-geriatric population, it is important to repeat the study design in larger and geographically diverse older samples for stronger conclusions.

This study revealed how the ICD-10-AM, Scored PG-SGA and the MNA can have significant differences in how they classify the nutrition status of patients. These differences may arise from the different methods used to assess nutrition status as well as the cut-points used in the continuous scores (for Scored PG-SGA and MNA only).

Regarding the ICD-10-AM and the Scored PG-SGA, both assessment tools seemed to have agreement between which participants were well-nourished and those that have some degree of malnutrition, where the ICD-10-AM considered 31 participants (54%) well-nourished and the Scored PG-SGA considered 27 (47%). However, the tools disagree in the consideration of the severity of malnutrition, where the ICD-10-AM considers 20 participants (35%) to have mild-moderate malnutrition and only 6 participants (11%) to be severely malnourished. Conversely, the Scored PG-SGA considers an equal number of participants to have moderate or suspected malnutrition and severe malnutrition (15 participants, 26% in each group). When examining how each assessment tool is scored (chapter 2.5.3 and appendix IX), one of the largest differences between the tools is the difference in the classification of severity of weight loss. Specifically, the ICD-10-AM (as described in chapter 2.5.4) classifies an individual as severely malnourished only when weight-loss exceeds 10% in an unknown period of time, whereas the Scored PG-SGA considers an individual as severely malnourished with >5% weight loss in 1 month, >10 in 6 months OR no weight stabilisation. Other differences between the tools may arise when you consider that in order to be classified as severely malnourished by the ICD-10-AM, a participant must have >10% weight loss AND suboptimal intake AND severe subcutaneous fat loss and/or severe muscle wasting. Conversely, the Scored PG-SGA is much more subjective and flexible in scoring, and may classify someone severely malnourished if there is significant weight loss but perhaps only moderate fat/muscle wasting, as may occur in obese individuals. Therefore, these difference between the tools may lead to more individuals being classified as severely malnourished by the Scored PG-SGA than the ICD-10-AM.

The difference in the categorisation between the MNA and the ICD-10AM and Scored PG-SGA are much more significant than that between the Scored PG-SGA and ICD-10-AM (revealed by the poorer sensitivity and agreement of the MNA). Although a direct comparison of the Scored PG-SGA and the MNA is beyond the scope of this study, inferences may be made by considering the strong concurrent validity of the Scored PG-SGA with the ICD-10-AM. Compared to the ICD-10-AM and the Scored PG-SGA, the MNA considered substantially fewer participants as well nourished (8 participants, 14%,

versus 31 and 27 participants, 54 and 47% respectively). Interestingly, the MNA considered approximately the same number of participants as malnourished (regardless of degree of malnutrition) as the Scored PG-SGA considered severely malnourished (16 participants, 28%, compared with 15 participants, 26% respectively). Therefore, all three tools deviated in regards to the severity of malnutrition. Although the number is approximately the same, as the Scored PG-SGA and MNA are not directly compared, it is not known if the same participants were considered severely malnourished by the Scored PG-SGA as malnourished by the MNA.

The main difference in the MNA compared to the ICD-10-AM and the Scored PG-SGA appears to be in regard to the group classified as “risk of malnutrition”. The MNA considers the majority of participants to be at risk of malnutrition, leading to fewer participants being classified as both well-nourished and malnourished. As revealed by examining the questions and scoring of the MNA (appendix VII), the tool cannot be easily compared with the Scored PG-SGA or the ICD-10-AM due to the consideration of different assessment components. An example is the use of calf and mid-arm circumference, independence of living arrangements and self-perceived view of health which are not considered by the ICD-10-AM or Scored PG-SGA. In regard to classifying an individual as at risk of malnutrition as opposed to well-nourished (as considered by the ICD-10-AM), the MNA has been previously criticised. Interestingly, the MNA has previously been considered to overestimate the risk of malnutrition in health care settings, due to limitations in question design (Read et al., 2005). These limitations in question design include that the tool does not consider oral nutrition support or a preference for small frequent meals (the patient must eat three full meals); in addition taking three or more prescribed medications may not be detrimental to nutrition status but is penalised indiscriminately. However, the current study found that although the MNA may have overestimated participants at risk of malnutrition, more importantly, it failed to identify malnutrition, where participants were incorrectly classified as at risk of malnutrition, when compared to the ICD-10-AM. Furthermore, the clinical relevance of these findings must be considered. The overestimation of risk of malnutrition in older adults cannot be detrimental to health outcomes, as a person who may be well-nourished will only receive additional nutrition support and monitoring. The more clinically relevant finding is the underdiagnoses of malnutrition, as persons may not receive the full nutrition support and monitoring required for the severity of their condition.

5.4 The identification of malnutrition in the rehabilitation setting

5.4.1 Introduction

As described in chapter 1.4, malnutrition is currently under-recognised and underdiagnosed in health and aged care settings; however, evidence for best practice has not been reviewed since August 2006 (Watterson et al., 2009). Furthermore, the previous review included limitations such as no critical evaluation of validity studies and providing unreliable prevalence data due to using inconsistent methods of diagnosis, no consideration of sample characteristics such as geographical location or ethnicity, and only considering a small number of studies (Watterson et al., 2009).

Therefore, in 2015 a narrative review was undertaken to provide an update on the *Evidenced Based Practice Guidelines for the Nutritional Management of Malnutrition in Adults Patients Across the Continuum of Care* in relation to the identification of malnutrition in rehabilitation, including the defining characteristics and prevalence of malnutrition in sufficient detail to enable clinicians to understand and minimise the risk of mis- and under-diagnosis. Furthermore, the review describes how the validity studies described in chapters 5.2.2 and 5.3.2 contribute to the current body of evidence, and opportunities for improving the evidence-base for identifying malnutrition in rehabilitation. Specifically, the aims of this narrative review were: 1) examine the defining characteristics of malnutrition, starvation, sarcopenia and cachexia; 2) review the validity of nutrition screening tools and nutrition assessment tools in the rehabilitation setting; and 3) determine the prevalence of malnutrition in the rehabilitation setting by geographical region and method of diagnosis.

5.4.2 Publication

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Review article

Protein-energy malnutrition in the rehabilitation setting: Evidence to improve identification



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ABSTRACT

Methods of identifying malnutrition in the rehabilitation setting require further examination so that patient outcomes may be improved. The purpose of this narrative review was to: (1) examine the defining characteristics of malnutrition, starvation, sarcopenia and cachexia; (2) review the validity of nutrition screening tools and nutrition assessment tools in the rehabilitation setting; and (3) determine the prevalence of malnutrition in the rehabilitation setting by geographical region and method of diagnosis. A narrative review was conducted drawing upon international literature. Starvation represents one form of malnutrition. Inadequate energy and protein intake are the critical factor in the aetiology of malnutrition, which is distinct from sarcopenia and cachexia. Eight nutrition screening tools and two nutrition assessment tools have been evaluated for criterion validity in the rehabilitation setting, and consideration must be given to the resources of the facility and the patient group in order to select the appropriate tool. The prevalence of malnutrition in the rehabilitation setting ranges from 14–65% worldwide with the highest prevalence reported in rural, European and Australian settings. Malnutrition is highly prevalent in the rehabilitation setting, and consideration must be given to the patient group when determining the most appropriate method of identification so that resources may be used efficaciously and the chance of misdiagnosis minimised.

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Contents

1. Introduction.....	78
2. Methods.....	78
3. Defining malnutrition.....	78
3.1. Malnutrition, starvation, sarcopenia or cachexia?.....	78
4. Identifying and diagnosing malnutrition.....	79
4.1. Malnutrition screening tools.....	79
4.2. Nutrition assessment tools.....	79
4.3. Body mass index.....	80
5. Malnutrition prevalence in older adults admitted to rehabilitation.....	80
6. Conclusion.....	83
Conflict of interest.....	83
Authorship declaration.....	83
Funding disclosure.....	83
Provenance and peer review.....	84
Acknowledgements.....	84
References.....	84

Abbreviations: AND, Academy of Nutrition and Dietetics; BMI, body mass index; Kg, kilogram; m, meter; MNA, Mini Nutritional Assessment; MNA-SF, Mini Nutritional Assessment–Short Form; MST, Malnutrition Screening Tool; PG-SGA, Patient-Generated Subjective Global Assessment; SGA, Subjective Global Assessment; UK, United Kingdom; USA, United States of America.

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1. Introduction

Ever since Dr Charles Edwin Butterworth Jr's seminal 1974 article "The Skeleton in the Hospital Closet", there has been a positive movement in clinical health care to address "hospital malnutrition" [1]. However, in highly developed countries, such as Australia and the UK, malnutrition remains widespread in older adults, where prevalence is the highest in rehabilitation wards (30–50% of inpatients) [2]. In addition, there has been confusion in the literature and in clinical practice regarding malnutrition, starvation, sarcopenia and cachexia in older adults, which are conditions characterised by involuntary loss of lean tissues [3].

Nutrition screening and nutrition assessment are essential parts of the nutrition care process, as accurate identification and diagnosis of malnutrition is required in order for patients to be adequately treated, and for nutrition resources to be used efficaciously [4]. However, it is essential that the nutrition screening tools and nutrition assessment tools used to complete these steps have undergone adequate evaluation for validity so that the most appropriate tool can be selected for the patient group [2].

The prevalence of malnutrition in rehabilitation and the nutrition screening and assessment tools appropriate for use in rehabilitation have not been reviewed since 2006 [2]. Examining the validity of nutrition screening and assessment tools in rehabilitation will help practitioners select the most appropriate tool for their facility. Additionally, understanding the limitations of a particular tool in a particular setting is required so that appropriate steps can be taken to minimise the risk of misdiagnosis. For this reason, the method of diagnosis should be considered when reviewing the prevalence of malnutrition. The prevalence of malnutrition in rehabilitation has not been evaluated with consideration given to the method of diagnosis, nor the various settings in which it was measured, such as rural *versus* metropolitan prevalence or by country or region. Understanding the prevalence of malnutrition in these various settings will help health care workers to understand the risk of malnutrition for particular patient groups and assist in the allocation of nutrition resources.

Therefore, the purpose of this narrative review was to: (1) examine the defining characteristics of malnutrition, starvation, sarcopenia and cachexia; (2) review the validity of nutrition screening tools and nutrition assessment tools in the rehabilitation setting; and (3) determine the prevalence of malnutrition in the rehabilitation setting by geographical region and method of diagnosis.

2. Methods

A narrative review was conducted which drew upon international literature published up until 15 August 2015. A review was conducted as part of the narrative review to identify the nutrition screening and assessment tools evaluated for validity in the inpatient rehabilitation facilities, as well as determine the prevalence of malnutrition. For this review, published English-language literature was searched on Google Scholar from 1980–15 August 2015. The search terms were ("MNA" OR "SGA" OR "PG-SGA" OR "ICD-10-AM" OR "Malnutrition Universal Screening Tool" OR "SNAQ" OR "NRS-2002" OR "nutrition screening tool") AND "Malnutrition" AND ("Rehabilitation" OR "Subacute"). The search strategy was complemented by a snowball search of literature cited by identified papers. Studies were included for the prevalence study only when malnutrition was diagnosed by a validated method.

3. Defining malnutrition

Protein-energy undernutrition, also known as protein-energy malnutrition, and frequently referred to simply as *malnutrition*,

occurs when food and nutrient intake is unable to meet protein, energy and nutrient requirements over time leading to a disruption of homeostasis in lean tissues, body weight and physical function [5,6]. Lean tissues include fat-free, metabolically active tissues such as skeletal muscle, viscera, blood cells and the immune system. Lean tissues are the largest body component, comprising 35–50% of the total body weight of a healthy adult [6]. A decrease in lean tissue is the main cause of unintentional weight loss in most cases of malnutrition, although loss of fat mass may also be a contributing factor, and is caused by starvation or a combination of starvation and catabolic stress [6].

3.1. Malnutrition, starvation, sarcopenia or cachexia?

It has been widely recognised that muscle mass frequently decreases with age. Malnutrition, starvation, sarcopenia and cachexia are all conditions characterised by loss of lean tissue and typically occur in older adults, leading to confusion in the literature and in clinical practice [3].

Starvation is the loss of both fat-mass and fat-free mass as the result of a chronic inadequate intake of protein and energy [3]. Therefore, starvation may be a cause of malnutrition, as reflected by the Academy of Nutrition and Dietetics (AND) standardised set of diagnostic characteristics for malnutrition: (a) starvation-related malnutrition, (b) chronic-disease related malnutrition and (c) acute disease or injury-related malnutrition [7]. The AND have defined starvation-related malnutrition as protein-energy malnutrition due to pure chronic starvation or anorexia nervosa [7]. Overall, starvation may be an important component of malnutrition in some clinical situations, but should be used with caution when discussing malnutrition in general.

Since being coined in 1989, the definition of "sarcopenia" has continued to evolve as the condition is further explored [8]. However, in 2009 and 2010 three separate groups of experts met to gain consensus for the definitions of sarcopenia. As each of these consensus definitions were slightly different, no definition is yet universally accepted and there still remains confusion and inconsistency in the literature when describing and diagnosing this "geriatric syndrome" [9]. However, all three definitions agree that sarcopenia is characterised by the progressive age-related loss of lean muscle mass, muscle strength and physical function, and is associated with poor health outcomes [10–12]. One important development in the consensus of sarcopenia is the recognition that inadequate dietary intake and/or nutrient malabsorption is a possible factor in the aetiology of the syndrome (known as nutrition-related sarcopenia) by the European Working Group on Sarcopenia [10]. However, both the International Working Group on Sarcopenia and the Society for Sarcopenia, Cachexia and Wasting Disorders have not recognised inadequate nutrition as a potential cause in the multifactorial aetiology of the syndrome; though they did recognise that it has a role in the pathophysiology of sarcopenia [11,12]. This may reflect the lack of strong research in exploring the nutritional mechanisms in sarcopenia along with the fact that it may be uncommon to find an older adult with sarcopenia who meets estimated energy and protein requirements [8]. However, there have not been enough well designed studies to conclude whether the severity or progression of sarcopenia is affected by dietary intervention. In addition, it may be possible for both malnutrition and sarcopenia to present as comorbidities, known as the malnutrition-sarcopenia syndrome (MSS); though it must be acknowledged a method of diagnosis for MSS has not yet been evaluated for validity or reliability [13].

Similar to disease-related malnutrition, cachexia is a complex syndrome associated with underlying illness, characterised by the loss of body weight, predominately skeletal muscle, which increases the risk of misdiagnosis [14]. Conditions which predis-

pose to cachexia also increase the risk of malnutrition, including cancer, chronic infection, and chronic kidney disease [14]. However, unlike malnutrition, the loss of skeletal muscle in cachexia is a result of increased resting energy expenditure mediated by elevated levels of proinflammatory cytokines and a prolonged acute phase protein response [15]. Therefore, cachexia is purported to not respond to dietary intervention, and states of malnutrition and sarcopenia have been described as a “pre-cachectic state”, where nutritional intervention may have the most benefit [14]. However, emerging research has shown that nutrition intervention may impact upon the pathogenesis of cachexia, although nutrition intervention alone is insufficient to treat the condition [14,16,17].

Therefore, inadequate energy and protein intake leading to a loss of lean-tissues in older age may play a role in the pathogenesis sarcopenia and cachexia, but is a critical factor in the aetiology and prognosis of all forms of malnutrition, including starvation. The diagnostic criteria of malnutrition, sarcopenia and cachexia help to highlight both the unique characteristics and similarities of each condition, and are compared in Table 1.

4. Identifying and diagnosing malnutrition

Due to the variable nature of the clinical presentation of malnutrition, there is no gold standard for diagnosing the condition. However, in Australian health care facilities, the *International Statistical Classification of Diseases and Health Related Problems 10th Revision Australian Modification* (sixth edition, ICD-10-AM) criteria are used to identify and code for malnutrition, and are therefore used to provide case-mix funding reimbursements [18]. The ICD-10-AM classification of malnutrition incorporate multiple criteria, including body mass index (BMI), weight loss, dietary intake and evidence of fat and/or muscle wasting [18]. However, prior to coding for malnutrition, a patient undergoes nutrition screening and nutrition assessment.

Nutrition screening acts as the trigger to engage a patient in the nutrition care process, which begins with nutrition assessment. Nutrition screening and nutrition assessment are often completed through the application of a nutrition screening tool and nutrition assessment tool [4]. However, the nutrition screening and assessment tools chosen should be validated for the population to which they are applied. As there is no gold standard for identifying or diagnosing malnutrition, the criterion validity (comprising concurrent and predictive) must be established for nutrition screening and assessment tools [19]. Concurrent validity is determined by comparing the results of a new tool to the results of a well-established measurement for the same construct. When considering the concurrent validity of a nutrition screening or assessment tool, it is important to consider the well-established measurement used as a benchmark (or reference standard), and if this is a relevant benchmark for a particular patient group and condition. Predictive validity is established when the score of a particular measurement makes an accurate prediction about an important and related outcome.

4.1. Malnutrition screening tools

Nutrition screening tools should be quick and simple to implement and able to be used by any trained person or the patient themselves. Nutrition screening tools determine risk of malnutrition but cannot make a diagnosis of malnutrition. In the rehabilitation setting, eight nutrition screening tools have been evaluated for their criterion validity: the Mini Nutrition Assessment-Short Form (MNA-SF) [20], Malnutrition Screening Tool (MST) [21,22], Malnutrition Universal Assessment Tool (MUST) [23], Nutritional Form for the Elderly (NUFFE) [24], Rapid

Screen [25], Short Nutritional Assessment Questionnaire (SNAQ) [26,27], SNAQ Residential Care (SNAQ^{RC}) [26,28] and the SNAQ for older adults (SNAQ⁶⁵⁺) [26,29]. A description of their domains and criteria are described by Skipper et al [30]. When evaluating the concurrent validity of a nutrition screening tool, sensitivity (those at risk of malnutrition correctly identified as such) is considered of higher importance than specificity (those not at risk of malnutrition correctly identified as such) and *a-priori* values of $\geq 80\%$ for sensitivity and $\geq 60\%$ for specificity are considered to indicate a good nutrition screening tool [22]. Table 2 compares the concurrent validity of nutrition screening tools in rehabilitation.

In the rehabilitation setting, only the MST, MUST, SNAQ and SNAQ⁶⁵⁺ met *a-priori* values for sensitivity and specificity; however, of these, only the MST met *a-priori* values compared to a suitable multidimensional benchmark for malnutrition. The NUFFE did not report sensitivity, specificity nor a kappa statistic, and therefore no conclusions could be drawn about its suitability for the rehabilitation setting.

The moderate agreement of the MNA-SF with the full Mini Nutritional Assessment (MNA), reported by Kaiser et al. [31], is expected as the MNA-SF was designed using the six questions from the full MNA which had the strongest correlations with the total MNA score. However, the two subsequent studies found the MNA-SF may not be appropriate for use in geriatric rehabilitation, as it was found to significantly overestimate the risk of malnutrition when compared to benchmarks unrelated to the MNA [18,21,26]. The SNAQ^{RC} was also found to overestimate the risk of malnutrition. Overestimating risk of malnutrition may lead to increased burden on nutrition resources, as all patients identified as at risk of malnutrition will be referred to the dietitian for a nutrition assessment. Therefore, the MNA-SF may be appropriate for a well-resourced rehabilitation facility focussed on both prevention and treatment of existing malnutrition [33–35]. The MNA-SF has displayed predictive validity for risk of institutionalisation and decreased physical function and quality of life in one study [36] and length of stay and poor participation in rehabilitation activities in a second study [37]. However, a two further studies found it was not able to predict length of stay, complications, physical function, rehospitalisation, institutionalisation, discharge location or mortality [21]. Apart from the MNA-SF, only the Rapid Screen displayed predictive validity, where it was able to predict discharge location [25]. The MST did not display predictive validity, whereas the MUST, NUFFE, SNAQ, SNAQ^{RC} and SNAQ⁶⁵⁺ were not evaluated for predictive validity. Overall, although some nutrition screening tools are suitable for identifying risk of malnutrition, there is insufficient evidence to determine if they are suitable predictors of patient outcomes in rehabilitation, which highlights the importance of following nutrition screening with a full nutrition assessment.

4.2. Nutrition assessment tools

The accuracy and reliability of global nutrition assessment tools in diagnosing malnutrition can be attributed to incorporating multiple criteria in their assessment, such as measures of anthropometry, medical status, physical function and dietary intake. The MNA and the Scored Patient-Generated Subjective Global Assessment (PG-SGA) have been evaluated for criterion validity in the rehabilitation setting [2]. Table 3 compares the concurrent validity of these nutrition assessment tools in rehabilitation facilities.

The two studies which evaluated the MNA as a continuous variable reported that it has good discriminatory power [38,39]; however, when using the recommended score of <17 to identify malnutrition, the lower sensitivity indicates the MNA categories carry a risk of labelling a patient “at risk of malnutrition” instead of “malnourished” in rehabilitation [39]. The two-tiered process employed by Visvanathan et al. [25] described in Table 3, has

Table 1
The diagnostic criteria of malnutrition, sarcopenia and cachexia.

Malnutrition ^a Diagnosis based upon criterion 1 or (criterion 2 plus criterion 3 plus criterion 4)	Sarcopenia ^c Diagnosis based upon criterion 1 plus (criterion 2 or criterion 3)	Cachexia ^g Diagnosis based upon (criterion 1 or criterion 2) and (criterion 3, criterion 4 or criterion 5)
Criterion 1: BMI ^b <18.5 kg/m ^{2d}	Criterion 1: Poor physical functioning (gait speed <1 m s ^{-1f})	Criterion 1: Unintentional weight loss (>5%) in 12 months or less in presence of underlying illness
Criterion 2: Unintentional weight loss (≥5%)	Criterion 2: Whole body lean mass <20th percentile	Criterion 2: BMI <20 kg/m ²
Criterion 3: Suboptimal intake	Criterion 3: Appendicular fat free mass ≤7.23 kg/m ² (men) or ≤5.67 kg/m ² (women)	Criterion 3: Fatigue
Criterion 4: Loss of fat and/or muscle		Criterion 4: Low fat-free mass (MUAMC ^h <10th percentile or appendicular skeletal muscle ≤7.25 kg/m ² (men) or ≤5.45 kg/m ² (women))
		Criterion 5: Abnormal biochemistry (albumin <32 g/L (3.2 g/dL ^k), CRP ^l >5.0 mg/L or IL-6 ⁿ >4.0 pg/mL ^p , or Hb ^q <3.2 g/dL)

^a Diagnosis of malnutrition according to the *International Statistical Classification of Diseases and Health Related Problems 10th Revision Australian Modification* (sixth edition, ICD-10-AM) [18].

^b BMI, body mass index.

^c kg, kilogram.

^d m, metre.

^e Diagnosis of sarcopenia according to the International Working Group on Sarcopenia [11].

^f m s⁻¹, meter per second.

^g Diagnosis of cachexia according to the Cachexia Consensus Working Group [14].

^h MUAMC, mid upper arm muscle circumference.

ⁱ g, gram.

^j L, litre.

^k dL, decilitre.

^l CRP, C-reactive protein.

^m mg, milligram.

ⁿ IL-6, Interleukin-6.

^o pg, pictogram.

^p mL, millilitre.

^q Hb, haemoglobin.

improved the sensitivity of the MNA. This suggests that caution should be used when employing the MNA in geriatric rehabilitation, and that patients found “at risk of malnutrition” may require further evaluation. However, as the number of patients classified as “at risk of malnutrition” by the MNA is usually high, this may have negative impacts on nutrition resources [39]. These results suggest MNA may require further study to identify a more appropriate cut-off value to diagnose malnutrition in geriatric rehabilitation.

One study reported that the Subjective Global Assessment (SGA) ratings of nutrition status were associated with anthropometric measures and grip strength, and had good reproducibility when used by medical officers in rehabilitation [41]. Although the criterion validity of the SGA has not been evaluated, the Scored PG-SGA ratings of nutrition status are analogous to the SGA ratings, and were found to have excellent concurrent validity when compared to the ICD-10-AM classification of malnutrition [39]. The Scored PG-SGA primarily differs from the SGA by including a continuous numerical score for intervention triage. This score was found to be an “excellent test” [40] and also displayed strong concurrent validity when using a score of 7 or higher to indicate malnutrition in this geriatric population as opposed to 9 or higher currently recommended on the tool for adult populations [39]. Both the MNA and Scored PG-SGA have shown strong predictive validity when compared with institutionalisation, discharge location and rehospitalisation [39]. In addition, the MNA and Scored PG-SGA scores have been found to be sensitive to change in nutrition status during the course of rehabilitation admission, and can therefore be used for monitoring and evaluation [42,43].

4.3. Body mass index

The BMI was first described by Adolphe Quetelet, a Belgian astronomer, mathematician, statistician and sociologist, between

1830 and 1850 [44]. The BMI, calculated by kg/m², has been classified into widely accepted categories of adiposity, where a BMI of ≤18.5 kg/m² is considered “underweight” and has been used to diagnose chronic malnutrition for individuals [18]. However, there is strong emerging evidence to suggest that the BMI of ≤18.5 kg/m² to indicate underweight is too low for older adults. In 2014, Winter et al. [45] published a meta-analysis which aimed to define BMI in community-dwelling older adults (≥65 years, *n* = 197,940 in total), and concluded that a BMI of <23 kg/m² may be considered underweight in community-dwelling older adults. However, it is important to acknowledge that malnutrition can occur in healthy weight or overweight/obese individuals [46]. Therefore, BMI may assist in the identification of chronic malnutrition in some patients, but should not be used as a sole method of screening or diagnosis.

For this reason, studies which use the BMI as a reference standard to evaluate the validity of nutrition screening and assessment tools should be interpreted with caution.

5. Malnutrition prevalence in older adults admitted to rehabilitation

As suggested in the revision of the concurrent validity of nutrition assessment tools, the reporting of malnutrition prevalence can vary depending on the method used to diagnose the condition. For example, is the nutrition assessment method known to under- or overdiagnose malnutrition? Furthermore, prevalence of malnutrition in rehabilitation is likely to differ by geographical location, such as by rurality or country, reflecting the access to resources and the population profile of the particular patient group. Therefore, due to the importance of the diagnosis method and the participant characteristics, prevalence was only considered when reported by the MNA (score of <17 to indicate malnutrition), the SGA and Scored PG-SGA (ratings B or C to indicate malnutrition) or the ICD-10-

Table 2

Comparison of the concurrent validity of nutrition screening tools evaluated in the rehabilitation setting.

Nutrition screening tool	Benchmark used	Population	Sensitivity	Specificity	Kappa statistic	Kappa statistic classification ^a
MNA-SF ^b – Kaiser et al. [31]	MNA ^c	<i>n</i> = 99, μ 74.9 \pm 6.2 years Rome, Italy	Not reported	Not reported	0.626	Substantial agreement
MNA-SF – Marshall et al. [21]	ICD-10-AM ^d	<i>n</i> = 57, μ 79.1 \pm 7.3 years NSW ^e , Australia	100%	22.6%	0.210	Fair agreement
MNA-SF – Hertroijs et al. [26]	BMI ^f or weight-loss	<i>n</i> = 366, μ 55 years Netherlands	92%	37%	Not reported	Not reported
MST ^g – Marshall et al. [21]	ICD-10-AM	<i>n</i> = 57, μ 79.1 \pm 7.3 years NSW, Australia	80.8%	67.7%	0.478	Moderate agreement
MUST ^h – Hertroijs et al. [26]	BMI or weight-loss	<i>n</i> = 366, μ 55 years Netherlands	100%	97%	Not reported	Not reported
NUFFE ⁱ – Söderhamn and Söderhamn, [24]	BMI, MAC ^j , CC ^k and MNA	<i>n</i> = 114, μ 78.0 \pm 6.3 years Western Sweden	Not reported	Not reported	Not reported	Not reported
Rapid Screen – Visvanathan et al. [25]	Standardised nutrition assessment	<i>n</i> = 65, μ 76.5–79.8 years SA ^l , Australia	78.6%	97.3%	Not reported	Not reported
SNAQ ^m – Hertroijs et al. [26]	BMI or weight-loss	<i>n</i> = 366, μ 55 years Netherlands	96%	71%	Not reported	Not reported
SNAQ ^{RC, n} – Hertroijs et al. [26]	BMI or weight-loss	<i>n</i> = 366, μ 55 years Netherlands	99%	48%	Not reported	Not reported
SNAQ ^{ES+, o} – Hertroijs et al. [26]	BMI or weight-loss	<i>n</i> = 366, μ 55 years Netherlands	96%	77%	Not reported	Not reported

^a Landis and Koch kappa statistic classification [32].^b MNA-SF, Mini Nutritional Assessment–Short Form.^c MNA, Mini Nutritional Assessment.^d ICD-10-AM, International Statistical Classification of Diseases and Health Related Problems 10th Revision Australian Modification (sixth edition) classifications for protein-energy malnutrition in adults.^e NSW, New South Wales.^f BMI, body mass index.^g MST, Malnutrition Screening Tool.^h MUST, Malnutrition Universal Assessment Tool.ⁱ NUFFE, Nutritional Form for the Elderly; Spearman rank correlations used to determine concurrent validity with the BMI at admission (r_s = −0.25, P = 0.008), BMI at discharge (r_s = −0.23, P = 0.014), MAC (r_s = −0.23, P = 0.014), CC (r_s = −0.25, P = 0.008) and the MNA (r_s = −0.74, P = 0.000).^j MAC, mid arm circumference.^k CC, calf circumference.^l SA, South Australia.^m SNAQ, Short Nutritional Assessment Questionnaire.ⁿ SNAQ^{RC}, Short Nutritional Assessment Questionnaire Residential Care.^o SNAQ^{ES+}, Short Nutritional Assessment Questionnaire for older adults.

AM criteria (E43, E44.0 or E44.1 to indicate malnutrition); and the patient group was described.

Seventeen studies were identified which reported the prevalence of malnutrition in the rehabilitation setting; two of which were in stroke rehabilitation [47,48], with the remaining 15 in general rehabilitation facilities (Table 4).

All malnutrition prevalence studies undertaken in the rehabilitation setting have had an older adult sample studies did not describe the age of participants [56–58]. No studies were identified reporting the malnutrition prevalence in rehabilitation in South America or Africa, and only one study reported the prevalence in North America [49]. Only two studies, both Australian, reported the prevalence of malnutrition in a rural population, where the

prevalence was high but varied according to type of nutrition assessment (SGA = 65% in one sample; ICD-10-AM criteria = 46%, Scored PG-SGA = 53%, MNA = 28% in a second sample) [39,57]. In two studies which also measured the prevalence of malnutrition in other settings, rehabilitation consistently had the highest prevalence [50,56]. The MNA was the most popular choice internationally for the assessment of nutrition status (n = 11 of 17 studies).

In metropolitan settings, the prevalence of malnutrition according to the MNA is inconsistent (0.06–68%), however when viewed by geographical location appears more consistent (33–53% in Europe and 14–24% in Asia and approximately 30% in Australia and North America). However, two studies reported outliers, 0.06% in Australia [36] and 68% in Italy [51]. It is unclear if these outliers

Table 3

Comparison of the concurrent validity of nutrition assessment tools evaluated in the rehabilitation setting.

Nutrition screening tool	Benchmark used	Population	ROC AUC ^a	ROC AUC classification ^b	Sensitivity	Specificity	Kappa statistic	Kappa statistic classification ^c
MNA ^d – Neumann et al. [38]	Body fat	<i>n</i> = 34, median 84 (IQR ^e , 78–88) years SA ^f , Australia	0.74	Good test	Not reported	Not reported	Not reported	Not reported
MNA – Marshall et al. [39]	ICD-10-AM ^g	<i>n</i> = 57, μ79.1 ± 7.3 years NSW ^h , Australia	0.85	Very good test	57.7%	96.8%	0.562	Moderate agreement
MNA ⁱ – Visvanathan et al. [25]	Standardised nutrition assessment	<i>n</i> = 65, μ76.5–79.8 years SA, Australia	N/A ^{j,k}	N/A	89.5%	87.5%	Not reported	Not reported
Scored PG-SGA ^l ratings – Marshall, et al. [39]	ICD-10-AM	<i>n</i> = 57, μ79.1 ± 7.3 years NSW, Australia	N/A ^k	N/A	100%	87.1%	0.860	Almost perfect agreement
Scored PG-SGA score ^m – Marshall, et al. [39]	ICD-10-AM	<i>n</i> = 57, μ79.1 ± 7.3 years NSW, Australia	0.910	Excellent test	92.3%	83.9%	0.7555	Substantial agreement

^a ROC AUC, Receiver Operating Characteristic Area Under the Curve.^b ROC AUC classification for the discriminative power of a test [40].^c Landis and Koch kappa statistic classification [32].^d MNA, Mini Nutritional Assessment.^e IQR, Interquartile range.^f SA, South Australia.^g ICD-10-AM, International Statistical Classification of Diseases and Health Related Problems 10th Revision Australian Modification (sixth edition) classifications for protein-energy malnutrition in adults.^h NSW, New South Wales.ⁱ Non-standard calculation of the MNA. A two-step process was used, where participants which were identified as "at risk of malnutrition" (score 17–23.5) underwent further nutritional assessment to re-classify as "malnourished" or "well-nourished". Traditional scoring of the MNA considers a participant "malnourished" if they scored <17, and "well-nourished" if they scored 17–30, which includes participants "at risk of malnutrition".^j N/A, Not applicable.^k ROC AUC applies to continuous variables only.^l PG-SGA, Patient-Generated Subjective Global Assessment.^m A score of 7 or more used to indicate "malnutrition" in geriatric rehabilitation [39].

Table 4

International prevalence of malnutrition in the rehabilitation setting to according nutrition assessment tools validated for the rehabilitation setting.

Study	Population	Diagnosis method	Prevalence
MNA in North America			
Thomas et al. [49]	• St Louis, USA • $n = 104$, $\mu 75.8$ years	MNA	29%
MNA in Europe			
Compan et al. [50]	• Nîmes, France • $n = 196$, $\mu 83.4 \pm 6.8$ years	MNA	33% ^a
Donini et al. [51]	• Rome, Italy • $n = 167$, $\mu 79$ –83 years	MNA	68%
Kaiser et al. [31]	• Rome, Italy • $n = 99$, $\mu 74.9 \pm 6.2$ years	MNA	41%
MNA in Asia			
Shum et al. [52]	• Regional Hong Kong • $n = 120$, $\mu 80.3 \pm 7.4$ years	Chinese MNA ^b	17%
Tsai et al. [47]	• Wen-Hua District, Taiwan ^c • $n = 74$, 82% were ≥ 60 years	MNA, MNA-TI (population specific) ^d	24% (MNA), 14% (MNA-TI)
MNA in Australia			
Visvanathan et al. [25]	• Adelaide, SA • $n = 65$, $\mu 76.5$ –79.8 years	MNA	29%
Neumann et al. [36]	• 3 Hospitals across SA • $n = 167$, $\mu 81 \pm 6$ years	MNA	0.06%
Charlton et al. [53]	• Sydney, NSW • $n = 2076$, $\mu 80.6 \pm 27.7$ years	MNA	33%
McDougall et al. [43]	• Melbourne, Victoria • $n = 114$, 83 ± 7 years	MNA	32%
Marshall et al. [39]	• Rural NSW • $n = 57$, $\mu 79.1 \pm 7.3$ years	MNA	28%
SGA in Europe			
Westergren et al. [48]	• Metropolitan Sweden ^e • $n = 162$, $\mu 78.62$ years	SGA ^f	32%
Westergren et al. [54]	• Metropolitan Sweden • $n = 520$, $\mu 81.0$ years	SGA ^f	46%
Andersson et al. [55]	• South Sweden • $n = 237$, $\mu 78.5$ –78.6 years	SGA ^f	34%
SGA in Australia			
Beck et al. [56]	• Wollongong, NSW • $n = 344$, age not described	SGA	49% ^g
Thomas, et al. [57]	• Ballarat, Victoria • $n = 20$, "geriatric", age not described	SGA	65%
Breik, et al. [58]	• Metropolitan Victoria • $n = 69$, age not described	SGA	49%
Scored PG-SGA in Australia			
Marshall et al. [39]	• Rural NSW • $n = 57$, $\mu 79.1 \pm 7.3$ years	Scored PG-SGA	53%
ICD-10-AM classification of protein-energy malnutrition in Australia			
Marshall et al. [39]	• Rural NSW • $n = 57$, $\mu 79.1 \pm 7.3$ years	ICD-10-AM	46%

CI, Confidence interval; ICD-10-AM, International Statistical Classification of Diseases and Health Related Problems, 10th Revision, Australian Modification; MNA, Mini Nutritional Assessment; SA, South Australia; PG-SGA, Patient-Generated Subjective Global Assessment; SGA, Subjective Global Assessment.

^a Compan et al. [50] found that rehabilitation had a higher prevalence than those in acute care (24.5%) or long-term residential care (24.7%).

^b Malnutrition is considered at an MNA score of <18.5 as opposed to the usual <17 in the modified Chinese MNA.

^c Result reported from a combined community and inpatient stroke rehabilitation study sample as opposed to a general rehabilitation inpatient sample.

^d Cut-points for the modified MNA-TI are not described by the authors.

^e Results reported from a stroke rehabilitation study sample as opposed to a general rehabilitation inpatient sample.

^f The SGA used in Sweden has four ratings of nutrition status, A–D instead of the usual A, B or C. The authors report malnutrition prevalence comprising ratings B–D.

^g Beck et al. [56] found that rehabilitation had the highest prevalence of malnutrition compared to other inpatient medical wards.

in reported prevalence of malnutrition by the MNA are due to a real difference in the severity of malnutrition in each study or due to possible differences in how the tool was implemented. When considering the low sensitivity of the MNA to identify malnutrition in geriatric rehabilitation (Table 3), the prevalence reported by the MNA may be underestimated generally [39]. The metropolitan prevalence of malnutrition according to the SGA was generally consistent according to studies from Australia and Sweden (32–49%).

6. Conclusion

The pathogenesis of malnutrition, including starvation-related malnutrition, is distinct from sarcopenia and cachexia; however, nutrition support may have a role in preventing or treating all conditions characterised by the loss of lean tissues. The MST has strong criterion validity; and the MUST, SNAQ and the SNAQ⁶⁵⁺ may also be appropriate for use as nutrition screening tools in rehabilitation. However, the MNA-SF and SNAQ^{RC} may only be appropriate for well-resourced settings focussed on prevention. The Rapid Screen and NUFFE require further evaluation of their validity before being recommended as a screening tool in the rehabilitation setting. Overall, nutrition screening tools require further investigation regarding their predictive validity, reliability and accuracy when used in practice. The Scored PG-SGA is appropriate for use as a nutrition assessment tool in rehabilitation; however, the MNA and BMI carry a risk that a malnourished patient may not be identified and may therefore not be appropriate as sole meth-

ods of diagnosis. Further research examining the MNA is needed in geriatric rehabilitation, including the evaluation of a new cut-off value for diagnosing malnutrition. Although the SGA can be considered appropriate for use, further evidence is needed regarding its criterion validity. Malnutrition in the rehabilitation setting is most prevalent in older adults, and ranges from 14–65% worldwide and is influenced by method of diagnosis, country and rurality. The highest prevalence of malnutrition has been reported in rural, European and Australian settings; however, further studies investigating the prevalence of malnutrition in North and South America and Africa, as well as studies reporting the prevalence in rural areas internationally, are required.

Conflict of interest

The author declares no conflicts of interest.

Authorship declaration

SM developed the research concept, conducted the literature review and critical analysis, and drafted and revised the manuscript.

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5.4.3 Statement of contribution to publication by author

Skye Marshall developed the study concept and carried out the literature review, data analysis, interpretation of data, drafting and revision of the manuscript. The narrative review included excerpts from chapters 2.1, 2.5 and 2.6.3, which were updated and included in this paper, along with the results from publications presented in chapters 5.2.2 and 5.3.2. Elizabeth Isenring provided supervision and guidance and Adrienne Young provided supervision; however, did not meet requirements to be included as authors.

5.4.4 Conclusion and implications for practice

This narrative review aimed to: 1) examine the defining characteristics of malnutrition, starvation, sarcopenia and cachexia; 2) review the validity of nutrition screening tools and nutrition assessment tools in the rehabilitation setting; and 3) determine the prevalence of malnutrition in the rehabilitation setting by geographical region and method of diagnosis. This is the first study to critically appraise and compare the criterion validity of nutrition screening and nutrition assessment tools in the rehabilitation setting. It is also the first study to examine the prevalence of malnutrition in rehabilitation with consideration given to method of diagnosis, rural versus metropolitan populations, and country. In addition, the study examines malnutrition in the context of other conditions which present with loss of lean tissues in older age, such as sarcopenia and cachexia. This will help to prevent misdiagnosis and understand the role of nutritional management in each of these conditions.

This review found that the prevalence of malnutrition in rehabilitation is the highest of any health care or community setting, but that Australian and rural settings have the highest prevalence internationally. In addition, it found further evidence to support the idea that malnutrition is a significant contributor to post-hospital syndrome, but may also increase the need for early institutionalisation.

The current review also highlights the importance of the studies reported in chapters 5.2.2 and 5.3.2, as these two studies have contributed the strongest criterion validity of any nutrition screening tool (the MST) and nutrition assessment tool (the Scored PG-SGA) in geriatric rehabilitation to date. However, the review also strengthens previous conclusions (chapters 5.2.5 and 5.3.5) as it found that there is further need for the evaluation of the criterion validity of nutrition screening tools and nutrition assessment tools in geriatric

rehabilitation. This includes further evaluation of the all nutrition screening and assessment tools in diverse samples of rehabilitation populations. Pragmatic validation studies are required to understand the accuracy and reliability of nutrition screening and assessment tools in a non-research setting; and further evidence was found to support the notion that the MNA may require a new cut-off value for diagnosing malnutrition in geriatric rehabilitation.

This review also supports the need for nutrition screening to be followed by nutrition assessment as it found that nutrition screening tools in rehabilitation do not have sufficient concurrent validity to correctly triage patients to nutrition intervention nor predictive validity to predict patient outcomes. However, overall, the most clinically relevant finding is that due to the high prevalence of malnutrition in geriatric rehabilitation, and the associated poor outcomes for patients and the health and aged care settings, sufficient dietetic and nutrition support must be provided to rehabilitation patients both during admission and post-discharge. This includes ensuring that the units are adequately staffed with dietitians as well as implementing a strong multidisciplinary nutrition policy. In order for this to be achieved, further research should aim to provide evidence for the efficacy of dietitians in rehabilitation, and nutrition and dietetic professionals and associations should advocate for adequate nutrition services to policy makers.

5.5 Conclusions

The research presented in chapter 5 confirms that the prevalence of malnutrition is high internationally, with Australia having one of the highest prevalence, especially in rural areas. Chapter 5 has significantly increased the evidence available for the identification of malnutrition, including several publications in high impact journals to help dissemination of these findings. Adoption of these findings by rehabilitation facilities and clinicians will significantly improve the identification of malnutrition in rehabilitation, so that strategies to prevent and treat malnutrition can be improved. This chapter found that malnourished older rehabilitation patients were more likely to be discharged from rehabilitation to RACFs or other accommodation than to return to their own homes, and were more likely to be readmitted to hospital for longer within three months. However, it is still unknown if these patients are at continued risk of malnutrition in their homes following discharge from

rehabilitation. Therefore, chapter 6 explores this transition and reports the change in nutrition status of malnourished patients as they transition from rehabilitation to home.

CHAPTER 6

MALNUTRITION ACROSS THE CONTINUUM OF CARE

6.1 The nutritional journey of malnourished older adults, with informal caregivers, from rehabilitation to home

6.1.1 Introduction

The systematic review in chapter 4 revealed that no study has measured the change in nutrition status in older adults following discharge from rehabilitation. It is therefore not known whether malnourished older adults are at risk of continued malnutrition once in the community (Marshall et al., 2014). Furthermore, the systematic review presented in chapter 3 concluded that engaging informal caregivers as part of the nutrition care team may improve the outcomes of malnourished older adults. Understanding the nutritional journey older adults make from home, to acute care, to rehabilitation and finally back to home may provide clinicians and researchers with insight into how to design and implement nutrition screening and intervention programs that best meet the needs of patients and their informal caregivers. Implementing these programs and providing nutrition support where it can make the strongest impact may further help to prevent discharge from rehabilitation to RACFs in previously community-dwelling older adults, in line with current goals of the Australian government (2012c). This is of particular importance in rural and remote Australia, due to the increased challenges in accessing, identifying and treating community-dwelling older adults with chronic disease (2011b). Therefore, a prospective cohort study was undertaken as part of the MARRC Study, which aimed to determine the nutritional status, physical function and HRQoL amongst malnourished older adults admitted to two rural rehabilitation units and 12 weeks post-discharge to the community.

6.1.2 Publications

Marshall S, Young A, Bauer J, Isenring E (2015) Malnourished older adults admitted to rehabilitation in rural New South Wales remain malnourished throughout rehabilitation and once discharged back to the community: a prospective cohort study. *Journal of Aging Research and Clinical Practice*, **4**(4), 197-204⁹. DOI: 10.14283/jarcp.2015.72. *Number of citations by date of thesis submission: 2.*

This study has also been published or presented elsewhere:

- *Oral presentations:* **Skye Marshall**, Adrienne Young, Judith Bauer, Elizabeth Isenring. Malnourished older adults with informal caregivers admitted to rural

⁹ Page numbers of the featured publication correspond with the journal publication and not with this thesis.

rehabilitation units remain malnourished during and after rehabilitation: A prospective cohort study of current practice. IAGG Asia/Oceania, 19-22 October 2015, Chiang Mai, Thailand, October 2015.

- *Oral presentation:* **Skye Marshall**, Adrienne Young, Judith Bauer, Elizabeth Isenring. Malnourished older adults with informal caregivers admitted to rural rehabilitation units remain malnourished during and after rehabilitation: A prospective cohort study of current practice. Accepted for table-top presentation to be delivered at the Australian Association of Gerontology's National Conference, Alice Springs, November 2015.
- *Poster presentation:* **Skye Marshall**, Adrienne Young, Judith Bauer, Elizabeth Isenring. Malnourished older adults with informal caregivers admitted to rural rehabilitation units remain malnourished during and after rehabilitation: a prospective cohort study of current practice. Presented at Bond University Faculty of Health Sciences and Medicine Higher Degree Research Conference, Robina, November 2015.

MALNOURISHED OLDER ADULTS ADMITTED TO REHABILITATION IN RURAL NEW SOUTH WALES REMAIN MALNOURISHED THROUGHOUT REHABILITATION AND ONCE DISCHARGED BACK TO THE COMMUNITY: A PROSPECTIVE COHORT STUDY

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Abstract: *Objectives:* Understanding the nutritional journey that older adults make from rehabilitation to home will help to target nutrition screening and intervention programs. This study aimed to determine the nutritional status, physical function and health-related quality of life amongst malnourished older adults admitted to two rural rehabilitation units and 12 weeks post-discharge to the community. *Design:* Observational prospective cohort study, conducted August 2013 to February 2014. *Setting:* Rehabilitation units in rural New South Wales, Australia. *Participants:* Thirty community-dwelling, malnourished older adult inpatients (mean age 79.5±7.1 years, 57% female). *Intervention:* Observation of usual care: basic nutrition services typical to rural rehabilitation units. *Measurements:* Outcome assessments were measured at rehabilitation admission, discharge and 12 weeks post-discharge, with nutrition status via the Scored Patient-Generated Subjective Global Assessment as the primary outcome measure. Secondary outcome measures included physical function (Modified Barthel Index) and health-related quality of life (Assessment of Quality of Life-6D). *Results:* At admission, half of the rehabilitation patients were moderately malnourished and half were severely malnourished, with the cohort becoming and remaining moderately malnourished on discharge and 12 weeks post-discharge. Only four patients (24%) were well-nourished 12 weeks post-discharge. Following discharge, there was a trend showing decline in physical function. No improvement was found in health-related quality of life following discharge. *Conclusion:* Malnourished older adults admitted to rural rehabilitation units with basic nutrition care are likely to be discharged with moderate malnutrition, and remain moderately malnourished in the community for at least 12 weeks. Physical function and health-related quality of life remain poor in this population. Collaboration between health services and within the multidisciplinary team is essential to identify and treat malnourished older adults, and novel approaches for inpatient and post-discharge nutrition support is needed.

Key words: Rehabilitation, aged, malnutrition, community, nutrition status.

Introduction

The ageing population has caused a shift in the type of health care demanded, including an increased preference for independent living (1). Rehabilitation facilities play a vital role in increasing independence so that older adults with disability may return safely to the community. Rehabilitation is therefore likely to increase in importance

to the health care system as the proportion of older adults rises.

Malnutrition (undernutrition) is an expensive consequence and cause of disease. Between 30 and 60% of rehabilitation older inpatients are malnourished, which presents a substantial economic and clinical challenge to rehabilitation facilities (2-4). A recent systematic literature review found that older adults admitted to rehabilitation with malnutrition had poorer health-related quality of life (HRQoL) and increased physical dysfunction, hospitalisation, institutionalisation and mortality once discharged to the community (4). However, no study has measured nutrition status in older adults following discharge from rehabilitation. It is therefore not known whether malnourished older adults are at risk of continued malnutrition once

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in the community (4). Understanding the nutritional journey older adults make from rehabilitation to home will help target nutrition screening and intervention programs. This is of particular importance in rural and remote Australia, due to the increased challenges in accessing, identifying and treating community-dwelling older adults with chronic disease (1). These challenges include a wide geographical spread, increased health care costs, limited health services, less availability of suitably qualified health professionals, less availability of informal care, and overall poorer health of the older adults (1). Therefore, this study aimed to determine the change in nutritional status, physical function and health-related quality of life amongst malnourished older adults admitted to two rural rehabilitation units and 12 weeks post-discharge to the community.

Methods

Design

This study was implemented as an observational prospective cohort study with data collected from August 2013 to February 2014.

Participants

Two public general rehabilitation units (24 and 31 beds) in the same local health district in rural New South Wales, Australia were chosen based on location. Participants were English-speaking inpatients ≥ 65 years who were malnourished on admission (as assessed using the Scored Patient-Generated Subjective Global Assessment, PG-SGA (5)) and were chosen by consecutive sampling. Participants were eligible if they were community-dwelling prior to admission and had an informal caregiver. This includes community-dwelling patients transferred from acute care. Well nourished (Scored PG-SGA rating A) patients were excluded. The rehabilitation units do not admit patients with dementia.

Routine clinical care

Participants were placed on a high-protein high-energy (HPHE) food service diet code menu unless contraindicated by medical condition. The units each have approximately 0.15 full time equivalent (FTE, six hours per week) of dietetic services, significantly less than the recommended minimum of 1.0 and 1.25 FTE for units with 24 and 31 beds (6). Participants received individualised medical nutrition therapy by the rehabilitation dietitian only if referred by the rehabilitation team as part of usual care, which included nutrition screening on admission via the Malnutrition Screening Tool (7). Referrals were also made by the rehabilitation team if any nutritional problems became

apparent to the team. Usual post-discharge nutrition support may include referral to publically-funded dietitian outpatient clinics, depending on individual patient needs and consent by the patient for the referral.

Nutritional assessment

The nutrition status of participants was assessed by the Scored PG-SGA (primary outcome measure) at admission (T1), discharge (T2) and 12 weeks post-discharge to the community (T3). If two data collection time-points occurred within six days, assessment of nutrition status was not repeated and it was assumed the nutrition assessment results had not changed in that short time period.

The Scored PG-SGA is a nutrition assessment tool that determines nutritional status based on medical history (weight change, dietary intake, symptoms that impact nutrition status and functional capacity) and physical examination (muscle and fat stores); and is sensitive to changes in nutrition status over a short period of time (8). It provides a continuous numerical score (with score of 7+ indicating malnutrition in older rehabilitation inpatients (9)), as well as a global rating of nutrition status for a nutritional diagnosis ("A" indicating 'well nourished', "B" indicating 'moderate or suspected malnutrition', "C" indicating 'severe malnutrition') (5, 10). A higher numerical score indicates increased malnutrition/risk for malnutrition. A reduction in score on repeat measures indicates that nutrition status has improved. The Scored PG-SGA has shown strong concurrent and predictive validity in the geriatric rehabilitation setting (9).

Weight was measured using Tanita scales (BC-541, 2005, Tanita Corporation, Tokyo, Japan). If a participant was unable to stand unassisted then the rehabilitation ward chair or roll-on scales were used. All three scales were within 0.1kg calibration. Weights reported for amputees were adjusted using standard algorithms (11, 12). Knee height was measured using a sliding knee height caliper and used to estimate height using a population specific formula (13, 14). BMI was calculated kg/m^2 , and classifications for older adults used to determine underweight ($<23 \text{ kg/m}^2$) and overweight/obese ($>30 \text{ kg/m}^2$) (15).

Physical function and health-related quality of life

The Modified Barthel Index (MBI) (16), a measure of physical function, and Assessment of Quality of Life (AQoL-6D) (17), a measure of HRQoL, were measured at discharge (T2) and 12 weeks post-discharge to the community (T3). The MBI (16) provides a numerical score (0-100, with 100 indicating total independence) as well as categories indicating dependency level (table 2) (16). The

AQoL-6D is a multi-attribute assessment tool providing a numerical score (17). All outcome measurement tools were completed on behalf of the participant by the primary researcher, an Accredited Practising Dietitian, by verbal interview with the participant. Supplementary information was recorded from the patient's medical record, for example medications and list of comorbidities. Further clarification was sought from their informal caregiver or the rehabilitation staff if the participant's account was unreliable due to fatigue or limited short-term recall following acute illness.

Participant characteristics

Participant descriptors and potential confounding variables, including age, gender, living arrangements, medical status and cultural background were identified from the participants' medical notes and self-reported by the participant. Cognitive impairment was assessed by occupational therapists as part of routine care.

Statistical approach

All statistical analysis was completed using SPSS version 22.0 [2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.]. Descriptive statistics were used to characterise participant descriptors and to report the outcome measures of the sample population (mean \pm SD/SE for normal variables, median (IQR) for skewed variables). Normality was assessed using the Shapiro-Wilk test. Change in nutrition status (Scored PG-SGA score) was determined by a linear mixed model to account for attrition and variation between the participants. The time-point was used as a repeated measures factor and the scaled identity as the covariance matrix of the random effect 'participant'. The analysis was carried out using the Restricted Maximum Likelihood method. Estimated Marginal Means were obtained, and pairwise comparisons using a Bonferroni adjustment were produced. The mean Scored PG-SGA score at each time-point was reported using these Estimated Marginal Means as opposed to observed means. Within-subject changes over time for nutrition status (Scored PG-SGA ratings) were examined between each of the three time-points and between the two time-points (T2 and T3) for physical function and HRQoL. Continuous variables were assessed using the paired t-test, and categorical variables using the paired-samples sign test.

Ethical consideration

The MARRC (Malnutrition in the Rural Rehabilitation Community) Study has been registered at the Australian New Zealand Clinical Trials Registry (ANZCTR: ACTRN12613000518763, Trial version

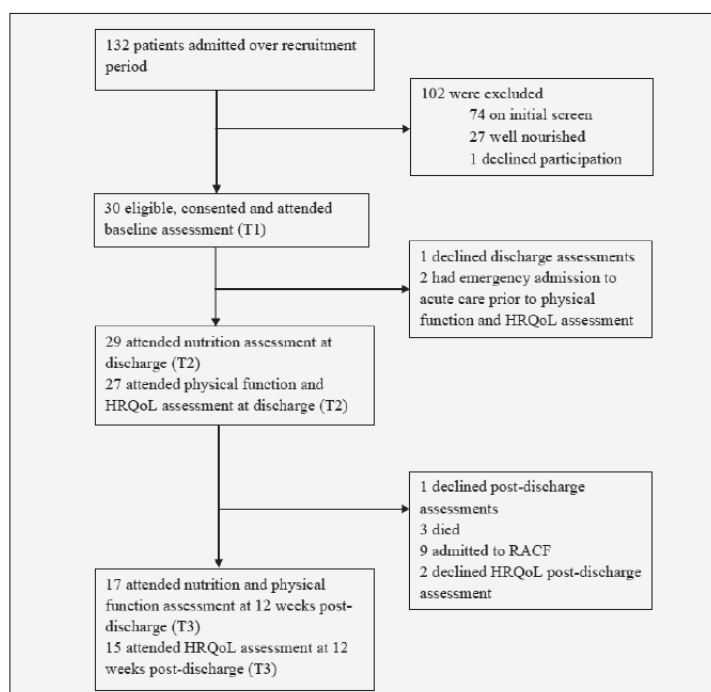
2.0, 10 July 2013) and has received ethical and governance approval (North Coast Human Research Ethics Committee approval number LNR 063, G108 and University of Queensland School of Human Movement Studies Ethics Committee approval number HMS13/0731). Written informed consent was obtained from all participants and/or their guardians.

Results

Sample population

Thirty-one eligible patients were admitted during the recruitment period, of which 30 provided informed consent (response rate 97%). Table 1 describes the characteristics of the participants in total and by rehabilitation site. Site A was found to have a significantly younger sample population, and a higher rate of admissions from the community than site B. Participant flow throughout the study is represented in Figure 1. Overall attrition was 43%. Excluding three participants who had delayed discharge awaiting aged care placement, the length of stay ranged from 1 – 55 days, with a mean of 22.8 ± 12.8 days.

Figure 1
Patient flow through the three time-points: admission (T1), discharge (T2) and 12 weeks post-discharge (T3)



HRQoL, Health-related quality of life; RACF, Residential aged care facility

Twenty-three participants were placed on a HPHE diet code at admission; the main reason of contraindication was poorly-controlled diabetes. Approximately half ($n=16$) of the participants were referred to the

Table 1
Characteristics of participants by rehabilitation site and in total at admission

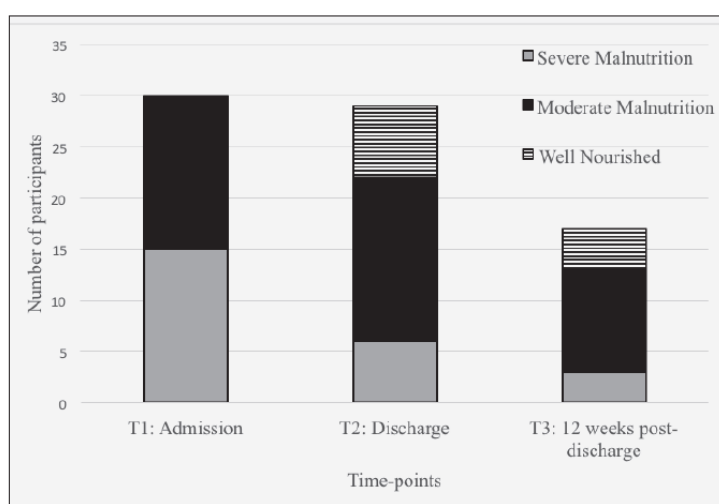
Variable	Site A (n=14)	Site B (n=16)	Total participants (n=30)
Age (years, mean±SD)	76.5±7.4	82.1±5.9*	79.5±7.1
Female (%)	50.0	62.5	56.7
Weight (kg; median, IQR)	55.5 (46.1-67.8)	58.1 (49.8-65.8)	56.2 (47.9-65.2)
BMI (kg/m ² ; median, IQR)	20.9 (17.5-20.9)	22.0 (20.9-23.4)	21.9 (19.4-23.5)
Underweight / BMI <23 (%)	64.3	43.8	66.7
Overweight / obese / BMI >30 (%)	21.4	12.5	16.7
Admission source:			
- Acute health care facility (%)	71.4	93.8**	86.7
- Community (%)	28.6	6.3	13.3
Reason for admission:			
- Acute illness (%)	64.3	100	80.0
- Chronic illness (%)	35.7	0.0	20.0
Living alone (%)	7.1	25.0	16.7
Education level:			
- Primary (%)	21.4	31.3	26.7
- Secondary (%)	14.3	37.5	26.7
- Tertiary (%)	57.1	6.3	3.3
- Trade (%)	0.0	18.8	36.7
Polypharmacy ^a (%)	100	93.8	96.7
Religion:			
- Christian (%)	85.7	62.5	73.3
- No religion (%)	14.3	25.0	20.0
- Other (%)	0.0	6.3	3.3
Ethnicity:			
- Aboriginal or Torres Strait Islander (%)	7.1	0.0	3.3
- Caucasian: European (%)	14.3	68.8	23.3
- Caucasian: Australasian (%)	78.6	31.3	73.3
- Other (%)	0.0	0.0	0.0
Cognitive impairment ^b :			
- MMSE (n=14) (mean±SD)		23.1±3.4	
- 3MS Test (n=20) (mean±SD)	79.0±15.9		
Pensioner (%)	85.7	81.3	83.3
Dentures (%)	57.1	81.3	70.0
Domiciliary services at T4	3	4	7
Community nursing services at T4	2	0	2

BMI, body mass index; IQR, interquartile range; SD, standard deviation. a. Considered ≥3 prescribed medications at the time of nutrition assessment; b. Not compared between sites due to difference in measurement tools; * Significant difference between sites (P=0.028); ** Significant difference between sites (P=0.022)

rehabilitation dietitian; these participants had a range of one to four (median 1.0) appointments with the dietitian. No participants were referred by the rehabilitation team to see a community dietitian on discharge as part of usual care. Nine of the 17 participants who attended the 12 week post-discharge assessment (T3) consented to a community dietitian referral; however, no participants had attended an appointment by six months post-discharge although multiple appointment times were offered. Furthermore, only 12% of participants received community nursing services following discharge, and 41% received domiciliary services (assistance with activities of daily living). Participants who reported weight one month prior to admission ($n=21$) lost a mean $3.1\pm 2.5\text{kg}$ ($4.8\pm 4.1\%$ body weight). Participants who reported weight six months prior to admission ($n=13$) reported a loss of $10.1\pm 4.4\text{kg}$ ($12.4\pm 5.8\%$ body weight).

Figure 2

Nutrition status of participants at each time point according to the Scored Patient-Generated Subjective Global Assessment (PG-SGA) ratings



Nutrition status

The Scored PG-SGA scores and ratings, BMI and weight of participants at each of the time-points are presented in table 2. The Scored PG-SGA score and ratings were found to be significantly lower at T2 and T3 than at admission (T1) indicating an improvement in nutrition status during admission and post-discharge. However, according to the Scored PG-SGA global rating and score, the cohort remained malnourished at all time-points, with the mean score above the cut-off of 7. Post hoc analysis revealed the improvement in the Scored PG-SGA score following admission was due to weight stabilisation and some improvements in dietary intake, nutrition impact symptoms, physical function and medical status. When admitted to rehabilitation, 50% of the participants ($n=15$) were rated 'moderately malnourished' and 50% ($n=15$) 'severely malnourished'

according to the Scored PG-SGA. Throughout the study period the cohort became or remained 'moderately malnourished', where only four participants (24%) were 'well-nourished' and three (18%) 'severely malnourished' at 12 weeks post-discharge. Most of the improvement in nutrition status according to the Scored PG-SGA ratings was due to a participant improving from 'severely malnourished' to 'moderately malnourished' during admission. An equal number of participants improved, declined and had no change in nutrition status between discharge (T2) and 12 weeks post-discharge (T3), resulting in no change in nutrition status of the overall group from discharge to 12 weeks post-discharge. The trend towards moderate malnutrition is represented in figure 2. There was no change in BMI or body weight throughout the study period and the mean BMI remained "underweight" ($\text{BMI} < 23\text{kg}/\text{m}^2$) at all time-points (table 2).

Physical function and health-related quality of life

The cohort had mild-moderate disability at discharge, and for those remaining in the study at 12 weeks there was no change in MBI score (table 2). Six of the eight participants scoring poorest in physical function (categories 1 - 3) at discharge did not attend follow-up at T3 due to admission to a residential aged care facility (RACF) or death. Categorically, a slight decline occurred in physical function, as only two participants improved in a category of physical function, nine had no change and six declined. No change was seen in HRQoL at 12 weeks post-discharge.

Discussion

This is the first study to measure the nutritional status of older adults following rehabilitation. Results suggest that the journey of the malnourished older adult from acute care, to rural rehabilitation facilities, to the community is bleak. Malnourished older adults admitted to rural rehabilitation units, whether severely or moderately malnourished, are likely to be discharged with moderate malnutrition, and remain moderately malnourished for at least 12 weeks in their homes. As patients were likely to be discharged with moderate malnutrition regardless of their length of stay, this suggests that the trend towards moderate malnutrition occurs early in the admission. Studies measuring nutrition status post-discharge from acute care facilities reported similar results in older adults (18, 19), indicating high risk for malnutrition following discharge from both acute and sub-acute health facilities.

The improvement in dietary intake and the decrease in nutrition impact symptoms prevented further weight loss from occurring; however the improvement was

Table 2

The nutrition status, physical function and quality of life of older adults at admission, discharge and 12 weeks post-discharge

	T1: Admission (n=30)	T2: Discharge (n=29)	T3: 12 weeks post-discharge (n=17)
Adjusted Scored PG-SGA score ^a			
- mean±SE	11.2±0.7	7.8±0.7*	8.3±0.9**
- mean change from T1	-	-3.4*	-2.9***
- mean change from T2	-	-	0.5
Scored PG-SGA rating ^b :			
- A: Well-nourished	-	7 (24.1%)*	4 (23.5%)*
- B: Moderately malnourished	15 (50%)	16 (55.2%)*	10 (58.8%)*
- C: Severely malnourished	15 (50%)	6 (20.7%)*	3 (17.6%)*
BMI kg/m ² (mean±SD)	22.3±4.3	22.3±4.3	22.0±4.5
Weight kg (mean±SD)	56.3±13.2	56.4±12.6	58.7±11.4
MBI score ^c (mean±SD)	-	74.5±23.0 ^e	78.9±18.1
MBI category ^{b,c} :			
- 5: Minimal		8 (29.6%) ^e	3 (17.7%)
- 4: Mild		11 (40.7%) ^e	11 (64.7%)
- 3: Moderate		4 (14.8%) ^e	2 (11.8%)
- 2: Severe		2 (7.4%) ^e	0
- 1: Total		2 (7.4%) ^e	1 (5.8%)
AQoL-6D score (mean±SD) ^d	-	0.65±0.26 ^e	0.69±0.16 ^f

AQoL, Assessment of Quality of Life Instrument; BMI, body mass index; MBI, Modified Barthel Index; PG-SGA, Patient-Generated Subjective Global Assessment; SD, standard deviation; SE, standard error; * Significantly different from T1 ($P<0.001$); ** Significantly different from T1 ($P=0.002$); *** Significantly different from T1 ($P=0.005$); **** Significantly different from T1 ($P=0.021$); a. A higher PG-SGA score indicates increased need for nutritional intervention (5). b. Categorical variables are presented as: number of participants (percent of participants); c. Range of the MBI is scored 0–99, where 0–24 indicates total dependency, 25–49 indicates severe dependency, 50–74 indicates moderate dependency, 75–90 indicates mild dependency, and 91–99 indicates minimal dependency (16); d. Range of the AQoL-6D is 0.00–1.00, where 0.00 is a state equal to death, and 1.00 is a state of full health. Negative values are possible, indicating states worse than death (17); e. $n=27$. Two participants could not attend assessment due to emergency admission to acute care; f. $n=15$. Two participant's data excluded as the participants declined to complete the assessment forms.

not significant enough to allow patients to regain the weight, fat and muscle stores they lost prior to admission. In addition, these findings may represent a 'best case' scenario, as the cohort had informal caregivers to provide support with activities of daily living at home, and therefore may have better nutritional outcomes than those without this support (20). The poor rate of referral to the rehabilitation dietitian by the rehabilitation team reflects findings in previous studies, indicating that poor compliance with nutrition screening and referral is widespread and significant (21–23).

The small increase in MBI score between discharge and 12 weeks follow-up in the community appears to be skewed by attrition, where participants with the lowest scores and the greatest disability did not attend follow-up assessment due to admission to an RACF or death. Therefore the downward trend seen in the categories of physical function is likely to be clinically significant, and aligns with previous findings (24). Despite the slight improvement, this cohort still had a poorer MBI score post-discharge than a similar study in an Australian

metropolitan rehabilitation unit (mean 78.9 versus 85.0 (24)). With continuing malnutrition and a downward trend physical function, it is no surprise that HRQoL remained lower than the Australian population norms for this age group ($\mu 0.65–0.69$ versus $\mu 0.75–0.77$ (25)).

Post-discharge attrition reported by similar studies is substantially lower, ranging from 0–31% (4). However, these sample populations included well-nourished older adults, and therefore attrition due to death and RACF admissions would be expected to be lower. Alternatively, the higher rate of attrition in the current study may suggest that institutionalisation and mortality are higher in this rural cohort than metropolitan communities. A lower rate of attrition in similar studies is also due to differences in study design, where patients were included for follow-up assessment if they were in the community, in an RACF or had died (24, 26–28), whereas the current study attended follow-up assessment only on patients discharged to the community. Participants in the current study were only enrolled if they were admitted to rehabilitation with the view they would be discharged

back to the community. The participants who had their discharge location changed from community to an RACF during admission were not excluded from the study and reported as attrition so that an accurate representation of the journey of community-dwelling malnourished older adults is reported.

Research and practice implications

From this study, it is clear that basic nutrition care with limited dietetic input during the inpatient rehabilitation admission is not sufficient to improve nutritional and functional status of malnourished older adults. Lack of referrals to the community dietitian on discharge, combined with poor attendance by participants referred at the conclusion of the study, highlights the need to review dietetic services and interventions during and after the rehabilitation setting.

Malnutrition is a significant and often silent contributor to 'post-hospital syndrome' which increases risk of rehospitalisation for conditions other than the original cause of admission (29). Therefore nutrition should be included in discharge summaries and handovers by medical, nursing and dietetic staff to ensure the continuum of care. Results suggest that early intervention is required in the geriatric rehabilitation setting. Advocacy by the multidisciplinary team for malnutrition to be of higher consideration on the rehabilitation agenda is called for.

The participants' informal caregivers were not involved in nutrition support in this study. The engagement of informal caregivers as part of the nutrition care team has been shown to be effective in improving the nutrition status of malnourished older adults in the community (30). Qualitative investigation is required to develop a patient-centred and informal caregiver-centred model of nutrition care for the rehabilitation setting. This model should be cost-effective, multidisciplinary and provide nutrition support during rehabilitation admission and post-discharge.

Limitations

A limitation of this paper is the small sample size which was related to a comparatively low patient turnover in rural rehabilitation units due to a longer length stay than in acute settings; however, the response rate was excellent in this at risk and hard to access population. In addition, results are of clinical significance and align with outcomes suggested by other studies in the geriatric rehabilitation setting which measured quality of life, physical function, health service use and mortality (4). The loss-to-follow-up 12 weeks post-discharge has been accounted for by the statistical approach, which lends confidence to the results.

Conclusion

Malnourished older adults admitted to rural rehabilitation units with basic nutrition care are likely to be discharged with moderate malnutrition, and remain moderately malnourished in the community for at least 12 weeks. Physical function and health-related quality of life remain poor in this population. Collaboration between health services and within the multidisciplinary team and sufficient dietetic services are essential to identify and treat malnourished older adults. Novel approaches for supporting patients and their informal caregivers during admission and post-discharge are needed. These results call for malnutrition to be of higher consideration on the rehabilitation agenda.

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6.1.3 Statement of contribution to publication by authors

Skye Marshall carried out the data collection, conducted the statistical analysis and interpretation of data, and drafted and revised the manuscript. Elizabeth Isenring contributed to data checking. Judith Bauer, Adrienne Young and Elizabeth Isenring provided supervision, guidance and revision of the manuscript.

6.1.4 Conclusion and implication of findings

This cohort study aimed to determine the nutritional status, physical function and HRQoL amongst malnourished older adults admitted to two rural rehabilitation units and 12 weeks post-discharge to the community. Results suggest that the journey of the malnourished older adult from acute care, to rural rehabilitation facilities and finally to the community is bleak. Malnourished older adults admitted to rural rehabilitation units, whether severely or moderately malnourished, are likely to be discharged with moderate malnutrition, and remain moderately malnourished for at least 12 weeks in their homes. Physical function and HRQoL remain below population norms. Furthermore, this study supports previous research which indicates that those malnourished older adults who are not able to remain in their homes, due to institutionalisation, are also at continued risk of malnutrition, poor quality of life and physical disability (chapter 4.2). Participants in this study had basic nutrition services (unit A: 6 hours of dietetic services, unit B: no allocated dietitian services, acute care dietitian will visit rehabilitation patients if time permits as a favour to the unit), and limited engagement of informal caregivers. Approximately half (n=16 of 30) of the participants were referred to the rehabilitation dietitian; these participants had a mean of 1.8 ± 1.1 appointments with the dietitian. Nine of the 17 participants who attended the 12 week post-discharge assessment (T3) consented to a community dietitian referral; however no participants had attended an appointment by six months post-discharge although multiple appointment times were offered.

Overall, malnourished older adults in this rural rehabilitation sample have not been adequately engaged with nutrition and dietetic services. This appears to be due to a) inadequate identification of malnourished patients by the rehabilitation team, or the poor referral rate of patients who are identified by the team, b) minimal engagement of the informal caregiver by nutrition services, c) inadequate intervention and follow-up by rehabilitation and community dietitians, most likely due to inadequate dietetic resources, and d) current post-discharge nutrition strategy of a referral to a free community-based dietetic clinic not accepted by sample.

The inadequate identification and referral of patients is likely to be exacerbated by inadequate dietetic services. Increased dietitian availability to the rehabilitation wards is likely to increase referral rate due to the availability of in-service training on nutrition screening and referral systems and a general increased awareness of malnutrition through activities such as staff interaction, participation in case conferences and medical note entries. Increased dietetic services may also allow for the availability of dietitians to engage with informal caregivers during the patients' stay, and increase the effectiveness of intervention by simply being able to complete the nutrition care process (appendix III) steps of monitoring and evaluation. It is unknown why patients did not attend the community-based dietetic clinic, and there may be multiple reasons such as they were unable to gain transport, they were resistant to intervention, they did not have motivation or were not well enough to attend, the purpose of the clinic/appointment was not understood, seeing a new dietitian was not desired, or possibly other unknown causes. The mode of post-discharge support desired by patients and informal caregivers should be examined so that services align with needs. In addition to this, the hypothesis that increased engagement of the dietitian with the patient and their informal caregiver during rehabilitation will increase post-discharge engagement should be further explored. The first step towards these investigations should be to meet the minimum standards for dietitian services at rehabilitation units (minimum standard 0.4-0.5FTE dietitian per 10 patients (2011h)), which requires increased advocacy by the nutrition and dietetics workforce and professional association.

In summary, malnourished older adults admitted to rehabilitation are likely to remain malnourished in the rural community and are not receiving nutrition support or follow-up. This correlates with the inadequate provision of nutrition services to the rehabilitation units, which may indicate that malnutrition is low on the rehabilitation agenda. Increased dietitian intervention and engagement of the informal caregiver as part of the nutrition care team early in rehabilitation provides an opportunity to improve patient outcomes once they are home. However, in order for interventions to be patient-centred and informal caregiver-centred, qualitative knowledge is required regarding the needs, experience and roles of the informal caregivers, both during rehabilitation and following discharge.

CHAPTER 7

EXAMINATION OF THE ROLES, EXPERIENCES AND NEEDS OF INFORMAL CAREGIVERS OF MALNOURISHED OLDER ADULTS IN THE REHABILITATION COMMUNITY

7.1 The perspective of female informal caregivers of malnourished older rehabilitation patients

7.1.1 Introduction

Chapters 1, 3 and 4 have demonstrated that enhancing the effectiveness of nutrition care to improve the overall health of older adults will be key in reducing hospital and aged care facility demand, a priority target of current health service research and policy (2007a; 2011b; 2011g). Chapters 2, 4 and 5 have revealed that the high prevalence of malnutrition in the older rehabilitation and community settings is of high concern due to the significant detrimental impact upon patient wellbeing and health and aged care facility use. This also presents a significant financial burden to the Australian health care system (Elia & Stratton, 2005; Pleuss, 2005; Skipper, 2012; Watterson et al., 2009).

The systematic review described in chapter 3 concluded that the engagement of informal caregivers is a promising area for preventing and treating malnutrition in community-dwelling older adults (Marshall et al., 2013). This review found that malnutrition-related interventions delivered to informal caregivers were able to improve or prevent decline in nutritional and functional status and quality of life, without increasing caregiver burden. The engagement of informal caregivers as part of the nutrition care team in rehabilitation presents a unique opportunity to increase the perceived value of nutrition support as the intervention will be centred on the needs and preferences of patients and their family members or friends, who provide the majority of their care. Another advantage is that patient and informal caregiver-centred interventions are likely to be highly cost-effective to health care systems. As the caregivers assume a larger role in the nutrition support of their care-recipients, the requirement for micro-management of nutritional intake by clinical dietetic and support staff will decrease. Therefore, clinical dietetic and support staff will have a larger scope in which to support the needs of malnourished older adults whom do not have informal caregivers.

The positive results found by the systematic review in community-based interventions suggests similar results may occur in the rehabilitation population. Although it is an inpatient setting where the caregiver is engaged, it is likely the patients will continue to receive nutritional support from their caregivers after discharge from rehabilitation to the community. When nutritional support is provided by family and friend caregivers, it is long-term with frequent points of contact, which may help explain the positive results upon the nutrition status of the patient. The need for this intervention was demonstrated by the

prospective cohort study reported in chapter 6.1.2, which found that when the informal caregiver is not engaged during rehabilitation, that malnourished older adults continue to remain malnourished during rehabilitation and at least three months in the community. The rehabilitation setting is an ideal location for these interventions to be included as part of clinical care as the longer length of stay allows increased opportunity to engage informal caregivers. Importantly, involving the informal caregiver will support the primary purpose of rehabilitation, which is to facilitate successful transitioning back to the community.

However, before an intervention can be implemented, there is a need to explore the capacity in which informal caregivers can be involved in nutrition interventions to improve successful transitioning of older adults admitted to rehabilitation back to the community and the impact this may have upon the older adult as well as the informal caregiver. Exploring this topic prior to intervention will ensure that intervention strategies are patient-centred, achieve a clinically meaningful improvement in nutrition status and help support the caring activities of informal caregivers, the majority of which are female (70% of primary carers in Australia) (2012e; Van Houtven et al., 2013). Therefore, in order to develop understanding and enhance the sensitivity of future interventions, a qualitative study was undertaken to explore this topic in the interpretive paradigm. This study aimed to determine the food- and nutrition-related roles, experiences and support needs of female informal caregivers of malnourished older adults admitted to rehabilitation units in rural NSW, Australia, both during admission and following discharge to the community.

7.1.1 Review of qualitative methodology

In order to select the framework most appropriate to explore the research question and to align with the skills and resources available, a review of qualitative methodologies was undertaken. A brief review of the topic “qualitative methodologies in health care research” was conducted to identify the prominent methodologies used in health care. Each theory was explored in terms of its definition and purpose, the types or variations of the methodology, the major features, modes of data collection and analysis and the methodologies’ application to health care research. Six methodologies were identified as relevant in exploring a qualitative topic in health care settings, and a summary of each of these methodologies is presented in table 7.1.

Table 7.1: Summary of the characteristics of prominent qualitative methodologies used in health care research

Definition	Types	Features	Data collection and analysis	Role in health care research
Ethnography (Atkinson & Hammersley, 2007; Savage, 2000)				
The writing of culture, studying human behaviour in a cultural context with a background in anthropology. Aims to understand the activities and meanings of particular groups. Seeks to determine thoughts, feelings and perceptions that drive meaning-making in a culture.	<ul style="list-style-type: none"> · <i>Doing</i>: using its methods to study culture. · <i>Writing</i>: producing a written account of ones interpretation of culture. · <i>Descriptive/conventional</i>: Description of cultures or groups, uncovering patterns. · <i>Critical</i>: describing cultures with an explicit ideological or political intent 	<ul style="list-style-type: none"> · <i>Emic versus Etic</i>: insider perspectives (emic) versus outsider perspectives (etic) · <i>Going Native Risk</i>: being overly influenced by the storytellers perspective · <i>First Order Concept</i>: common-sense perspectives on everyday life · <i>Second Order Concept</i>: abstract and theoretically based 	<ul style="list-style-type: none"> · Purposive sampling · Data collection heavily reliant on observation and interviews. · Thick description · Use of documents e.g. letters, newspapers · Use of key informants · Fieldwork: immersed in the data · Field notes: following Spradleys typology, progressive record of insights · Analysis: commences with data collection 	Does not usually produce findings which can be generalised Useful to generate research questions in a field with little previous research Methods often have complicated ethical issues
Feminist Approaches: Critical and Post-structuralist (2005b)				
Aims to create theory that can be used to build a fairer society with a background in Marxist and social beliefs. It is	<ul style="list-style-type: none"> · <i>Old types of feminism</i>: Liberal, Marxist and Radical · <i>Post-feminist</i>: men and women should be treated the same way 	<ul style="list-style-type: none"> · <i>Critical Research</i>: concerned with empowering the disadvantaged; examines social mechanisms of disempowerment 	<ul style="list-style-type: none"> · No specific methods for feminist research · Emic analysis · Emic and etic analysis 	<ul style="list-style-type: none"> · Provides a framework to involve social structures into health care design

Definition	Types	Features	Data collection and analysis	Role in health care research
concerned with issues of power, advantage and disadvantage, fairness and empowerment.	<ul style="list-style-type: none"> · <i>Post-structural feminism</i>: women are the same as men in some ways but different in other ways 	<ul style="list-style-type: none"> · <i>Principles of feminist research</i>: women are at the centre of the research; researchers own experiences are relevant; participant own their data; goal is to improve experiences and lives of women 	<ul style="list-style-type: none"> · Analysis aims to explain gaps or silences, identify recurrent themes, generate new concepts and build them into a theory 	<ul style="list-style-type: none"> · Useful to catalyse change in an environment
Grounded Theory (2005b; Glaser, 1992; Strauss & Corbin, 1998)				
A systematic and structured research method which generates a new theory to explain a social phenomenon through constant comparison of social processes. The theory has a high level of abstraction and is underpinned by the framework of symbolic interactionism. Focuses on meaning in interaction and seeks to explain how people act in	<ul style="list-style-type: none"> · <i>Straussian</i>: highly structured, uses “core category” to address specific research questions, risks linear thinking. · <i>Glaserian</i>: vague and flexible methods to suspend all preconceptions 	<ul style="list-style-type: none"> · <i>Research area</i>: a broad research area is used instead of a research question · <i>Depth</i>: much deeper in generating theory · <i>Bracketing</i>: to suspend all assumptions and pre-conceived ideas. · <i>Literature</i>: used in analysis rather than prior background knowledge · Data collection and analysis are intertwined 	<ul style="list-style-type: none"> · <i>Theoretical sampling</i>: continuous sampling based on emerging concepts and developing theory. · <i>Data collection</i>: mixed methods including field observations, interviews, diaries, clinical records, media, quantitative measures. · <i>Theoretical sensitivity</i>: sensitivity of researcher to detect meaning in data. 	<ul style="list-style-type: none"> · Despite being popular in nursing it has had minimal impact upon healthcare · Use when little is known about a phenomenon · Use to increase understand and collaboration within a specific work environment · Cannot be generalised to a population

Definition	Types	Features	Data collection and analysis	Role in health care research
relation to others (<i>interaction</i>), account for the actions (<i>symbolic</i>) of others and then reorganise their own actions (<i>action</i>).			<ul style="list-style-type: none"> · <i>Constant comparison</i>: method of analysis · <i>Integration of theory</i>: substantive theory versus formal theory 	
Narrative Inquiry (Clandinin, 2006; Holloway & Freshwater, 2007)				
Storytelling to understand the complex nature of human identity. Stories reveal truths about human experiences.	<ul style="list-style-type: none"> · <i>Narratives</i>: how participants represent themselves. May be via construction of identity, strategic, functional, purposeful · <i>Individual narratives</i>: used to understand the depth, via remembering the past, arguing with stories, experience of the narrator, entertainment, misleading · <i>Group narratives</i>: construction of identity combined with a community of stories 	<ul style="list-style-type: none"> · <i>Co-construction</i>: narrative is an expression of the participant and the researcher · <i>Storytelling</i>: Spoken, written or visual 	<ul style="list-style-type: none"> · Open questions · <i>Interviewing</i>: to generate detailed accounts · <i>Narrative Analysis</i>: case-centred (person by person) then cross compare. Stories are kept as a whole unit and not analysed as words 	<ul style="list-style-type: none"> · Group narratives can be used to catalyse change by vulnerable persons · Focus on person not on illness · Understand complexity and diversity
Phenomenology (2005b; Bassett, 2006)				
Capturing the lived experience, with the idea that	<ul style="list-style-type: none"> · <i>Hersserlian</i>: established phenomenology, and developed 	<ul style="list-style-type: none"> · <i>Phenomenological Reduction</i>: return to original awareness of a phenomenon 	<ul style="list-style-type: none"> · Each type of phenomenology employs specific 	<ul style="list-style-type: none"> · Hermeneutic phenomenology used to

Definition	Types	Features	Data collection and analysis	Role in health care research
experiences are richer than attitudes or opinions	<p>phenomenological reduction and intentionality. Later developed descriptive phenomenology, which is focussed on describing rather than interpreting a phenomenon</p> <ul style="list-style-type: none"> · <i>Heideggerian</i>: aims to understand the true meaning of a phenomenon via accurate interpretation and intuition · <i>Hermeneutics</i>: “interpretative phenomenology”, aims to interpret rather than describe a phenomenon. The study is a complete process to enhance validity · <i>Merleau-Ponty et. al</i>: “primacy of perception”, focussed on lived experience; on embodiment and being-in-the-world 	<ul style="list-style-type: none"> · <i>Intentionality</i>: the mind is able to form representations · <i>Primacy of perception</i> 	<p>methods of data collection and analysis</p> <ul style="list-style-type: none"> · <i>Bracketing</i>: necessary to suspend constantly to achieve phenomenological reduction · Open questions · <i>Mixed methods</i>: interviews, observation of art/craft, mind maps. · <i>Analysis</i>: Hermeneutic circle, reflexivity, thematic analysis. Group analysis techniques recommended 	<p>influence service delivery</p> <ul style="list-style-type: none"> · Frequently used in healthcare to provide richer perspective on a known phenomenon · Will not provide an answer but will increase understanding to improve practice
Participatory Action Research (PAR) (Koch & Kralik, 2009)				
A type of action research which aims	<ul style="list-style-type: none"> · PAR includes a range of practices and approaches 	<ul style="list-style-type: none"> · <i>Participation/partnership /democracy</i>: participants are 	Participants involved in all parts – design, data	PAR will translate into

Definition	Types	Features	Data collection and analysis	Role in health care research
to create social change ng to address inequality. It is concerned with developing practical knowing in the pursuit of worthwhile human purposes.	with varying assumptions that underpin the form. · <i>Koch and Kralicks PAR</i> : aims to create a democratic dialogue and stimulate reform. Focused on empowerment, self-awareness and increasing capacities	involved in all stages, equal relationships, researcher acts as a participant · Value of knowledge · <i>Theory</i> : is generated from experience, used to create change · <i>Impact</i> : PAR itself impacts participants, a type of intervention · Flexible and systematic · Implemented via a circular <i>Process</i> : Participation to knowledge in action to emerging developments to human flourishing.	collection, analysis, presentation Data collection by group via democracy, involves stories, meetings, audits, stakeholder consultations. reflecting, interpreting, explaining Analysis continuous reflection, interpretation and explaining during data collection and is followed by actions determined by the group	action / intervention quickly Ideal for clinical environments which constantly change High participant burden

By critically appraising the strength of each methodology to answer the research question, the skills of the researcher and the level of burden on participants, *interpretative phenomenological analysis (IPA)* was found to most closely align with the needs of this study. Interpretative phenomenological analysis is derived from Hermeneutic Phenomenology, or “Hermeneutics”, which is the science of interpretation of a phenomenon (2005b; Bassett, 2006). This methodology further incorporates ideas from Husserl, Heidegger and Merleau-Ponty, and is therefore focussed on interpreting the lived experience (2005b; Bassett, 2006). Interpretative phenomenological analysis is frequently used in health care research to facilitate understanding which may influence service delivery. Therefore, IPA was deemed suitable to guide a qualitative study which seeks to understand the roles and experiences of caregivers of malnourished older adults, to ultimately improve the nutrition support given to patients and their caregivers in rehabilitation and post-discharge. Although IPA has been used previously to explore food and nutrition-related experiences of individuals, it will be used as a guide only in the current study due to the limited experience of the researchers in qualitative research (Crogan et al., 2004; Dibsall et al., 2002; Scarpello et al., 2009).

7.1.2 Publication

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The nutrition and food-related roles, experiences and support needs of female family carers of malnourished older rehabilitation patients

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Author contributions: SM carried out the data collection, conducted the analysis and interpretation of data, and drafted the manuscript. EI and DR contributed to data analysis. SM, DR, AY and EI contributed to the study concept and revision of the manuscript.

Abstract

Background: In order to improve perceived value of nutrition support and patient outcomes, the purpose of this study was to determine the nutrition and food-related roles, experiences and support needs of female family carers of community-dwelling malnourished older adults admitted to rehabilitation units in rural NSW, Australia, both during admission and following discharge.

Methodology: Four female family carers of malnourished rehabilitation patients aged ≥ 65 years were interviewed during their care-recipients' rehabilitation admission and two weeks post-discharge. The semi-structured interviews were audiotaped, transcribed and analysed reflecting an interpretative phenomenological approach by three researchers. A series of "drivers" relevant to the research question were agreed upon and discussed.

Results: Three drivers were identified. "Responsibility" was related to the agency who assumed responsibility for providing nutrition support and understanding family carer obligation to provide nutrition support. "Family carer nutrition ethos" was related to how carer nutrition beliefs, knowledge and values impacted the nutrition support they provided, the high self-efficacy of family carers and an incongruence with an evidence-based approach for treating malnutrition. "Quality of life" was related to the carers' focus upon quality of life as a nutrition strategy and outcome for their care-recipients, and how nutrition support impacted upon carer burden.

Principal conclusions: Rehabilitation units and rehabilitation dietitians should recognise and support family carers of malnourished patients, which may ultimately lead to improved perceived benefit of care and patient outcomes. Intervention research is required in order to make strong recommendations for practice.

Introduction

Enhancing the effectiveness of nutritional care to improve the overall health of older adults will be key in reducing hospital and aged care facility demand, a priority target of current health service research and policy (1-3). Protein-energy malnutrition (herein referred to as ‘malnutrition’) is an expensive consequence and cause of disease and presents a significant burden to rehabilitation facilities, where approximately 14–65% of all older adults are malnourished worldwide (4-8). Furthermore, a recent study found that malnourished patients admitted to rural rehabilitation units were likely to be discharged with malnutrition and remain moderately malnourished for at least three months in their homes (9). Significantly, although all patients in this study had family carers (herein referred to as ‘carers’), these carers were not engaged by the rehabilitation nutrition support services (9).

There is good evidence that malnutrition-related interventions delivered to carers are able to improve or prevent decline in nutritional and functional status and quality of life, without increasing carer burden (10). The engagement of carers as part of the nutrition care team in rehabilitation presents a unique opportunity to improve nutrition care and outcomes, as the intervention is centered on the needs and preferences of patients and their family members or friends who provide the majority of their care. The rehabilitation setting is ideal for such interventions as the longer length of stay increases opportunities to engage carers. Importantly, involving the carers supports the primary purpose of rehabilitation, which is to facilitate successful transitioning back to the community or residential aged care.

Exploring the nutrition and food-related roles, experiences and needs of carers of malnourished older adults, both during and following the rehabilitation admission, could ensure the development of intervention strategies that are both patient-and carer-centred. Therefore, in order to inform the design and delivery of future nutrition support interventions for older rehabilitation patients and their carers, a qualitative exploration was undertaken to understand this phenomenon in the interpretive paradigm.

Research question

What are the nutrition and food-related roles, experiences and support needs of female family carers of community-dwelling malnourished older adults admitted to rehabilitation units in rural New South Wales (NSW), Australia, both during admission and following discharge?

Methods

Study design

This longitudinal qualitative investigation was implemented as part of the Malnutrition in the Rural Rehabilitation Community (MARRC) study. Semi-structured interviews were conducted at two time-points to understand the carer roles, experience and support needs during and after the rehabilitation stay, with analysis guided by interpretative phenomenological analysis (IPA). This approach was selected as the research was focussed on interpreting the lived experience of carers to inform future interventions to improve health service delivery (11-13).

Participants and setting

Participants were sampled from two public, general rehabilitation units (24 and 31 beds) in the same local health district in rural NSW, chosen by convenience based on location. Participants were eligible if they were English-speaking female family carers aged ≥ 18 years, and cared for a community-dwelling inpatient aged ≥ 65 years with malnutrition (determined by the rehabilitation dietitian). In order to produce a homogenous sample, female carers were chosen as they represent the majority of family carers (14); however, reflecting the IPA approach, a “representative” sample was not sought. For this study, a family carer was considered to be a family member or close friend who either lived with the older adult or did not live with the older adult but provided assistance with activities of daily living, with point-of-contact ≥ 4 days per week. Carers were identified from medical records and the older adult inpatient. Exclusion criteria for carers were: history of abusive or threatening behaviour; unsafe dwelling or a dwelling located ≥ 1.5 hours’ drive from the rehabilitation facility as per medical records.

Carers were identified through purposive sampling facilitated by the rehabilitation dietitian (independent of the research team) and the primary researcher (SM): all patients identified as at risk of malnutrition (via the Malnutrition Screening Tool (15)) were referred to the rehabilitation dietitian for full nutritional assessment. With permission from the patient, potentially eligible carers were approached by the researcher to invite them to participate. Reflecting the IPA approach (16, 17, 18), a small sample size of four participants (two daughters and two spouses) was considered appropriate for the current study.

The usual care for care-recipients was individualised medical nutrition therapy from the rehabilitation dietitian (0.15 full time equivalent per rehabilitation unit). Involvement of the carer occurred opportunistically at the discretion of the carer and the rehabilitation dietitian.

Usual post-discharge nutrition support may involve referral to publically-funded dietitian outpatient clinics and/or prescription of subsidised oral nutrition supplements. The researchers were not involved in the care of the care-recipients and provided no intervention.

Ethical considerations

Ethical and governance approvals were obtained as part of the MARRC Study (North Coast Human Research Ethics Committee approval number LNR 063, G108). Written informed consent was obtained from all carer participants. A small travel reimbursement (AU\$15) was offered to participants to cover transport costs; however two participants refused reimbursement. A waiver of consent was granted for the collection of basic demographic data from the rehabilitation inpatients (care-recipients).

Interviews

Care-recipients did not attend interviews. The primary researcher conducted face-to-face semi-structured interviews with carers at two time points (T1 and T2):

- T1) During the care-recipients' admission (at least 7 days post-admission) in a private room at the rehabilitation unit.
- T2) Two weeks post-discharge in a private room at the carers' home, workplace or at the rehabilitation unit.

The first carer interview was also a pilot, used to create the interview schedules (Online Supplementary Material 1 and 2) and trial the analysis. The primary researcher collected demographic data about the carer and their care-recipient via interview and medical records. During the interviews, the primary researcher maintained a journal of field observations and thoughts/impressions to aid data analysis.

Data analysis

Interviews were audio-recorded and transcribed verbatim by SM. Identifying information was removed from the transcripts. Codes were developed using qualitative analysis software (NVivo for Windows, Version 10. QSR International Pty Ltd, Australia). Thematic analysis was guided by the IPA method described by Smith et al. (17) and Phillips et al. (16, 19). Specifically:

1. Individual interview transcripts were studied independently and on multiple occasions by SM. Line by line coding was used, and potential themes (words or short phrases) developed for each interview, including contradictory extracts within a

- particular theme. A secondary researcher (EI) reviewed transcripts and codes; additional codes were produced and existing codes expanded.
2. Potential themes were discussed and compared by SM and EI until consensus resulted and a long list of themes created for each interview.
 3. Themes with commonality were grouped into “higher themes” for each interview. Divergences and convergences between linked interviews (T1 and T2 by the same participant) were particularly considered when developing higher themes.
 4. The nutrition and food-related significance of the higher themes were considered; those considered to be unrelated to food and nutrition or not relevant to the research question were excluded. Examples were the higher themes of medical status and non-food-related social interaction. Higher themes and their relevance were assessed by SM and confirmed with EI.
 5. Both researchers compared the higher themes across all interviews at each time-point (T1 and T2), producing “shared themes” that reflected commonalities across all interviews and time-points and the field notes of the primary researcher.
 6. Commonalities in shared themes were identified which allowed them to be further grouped into “super themes”, also known as “drivers”.
 7. From the literature, a relevant theoretical framework was selected to explain and interpret the drivers.
 8. The drivers and theoretical framework were used to describe and interpret the experience of carers during their care-recipient’s rehabilitation admission and post-discharge, and make suggestions for practice.

An electronic and paper-based audit trail was reviewed by a third, independent researcher (DR). Any disagreements or contested themes were discussed between the three researchers until consensus was reached. Final, agreed drivers’ encompassed themes occurring across most accounts and which best answered the research question. Findings were integrated with the discussion to support synthesis for the reader (20).

Findings and discussion

Four female participants were recruited from one rehabilitation unit only (Table 1). Interviews were conducted from July 2015 to January 2016, and all participants attended both interviews (T1 and T2). Each interview was conducted alone with the carer, with the exception of one interview (T1; Joan), which was also attended by Joan’s neighbour Vicky (pseudonym used) at the request of Joan. Vicky provided informed consent to participate in the study; however, her contribution was minimal. The T1 interviews were conducted from

11 – 28 days following admission and were 25 – 36 minutes duration, and the T2 interviews were conducted 12 – 21 days following the care-recipients discharge from rehabilitation and were 6 – 15 minutes. The T2 interviews were shorter than expected as carers' experiences and needs had not significantly changed since T1.

Table 1: Demographics of the female family carers and their malnourished care-recipients

Demographic	Amanda*	Jill*	Cindy*	Joan*
Family carer demographics				
Age	45 years	84 years	59 years	85 years
Relationship to care-recipient	Daughter	Wife	Daughter-in-law	Wife
Highest level of education	Trade	Tertiary	Tertiary	Secondary
Marital status	Divorced/separated	Married	Married	Married
Country of birth	Australia	Australia	Australia	England
English as first language	Yes	Yes	Yes	Yes
Ethnicity	Caucasian	Caucasian	Caucasian	Caucasian
Religion	No religion	Christianity	Christianity	No religion
Currently dieting	No	No	No	No
Pension	Single parent	Aged	None	Aged
Living with care-recipient	No	Yes	No	Yes
Assist care-recipient with grocery shopping	Yes	Yes	Yes	Yes
Assist care-recipient with food preparation	No	Yes	Yes	Yes
Care-recipient demographics				
Care-recipient*	Velma	Lester	Leona	Alfred
Care-recipient length of rehabilitation stay	36 days	42 days	35 days	32 days
Care-recipient age group	65 – 69 years	85 – 89 years	85 – 89 years	85 – 89 years
Care-recipient gender	Female	Male	Female	Male
Care-recipient discharge location	Home	Home	Residential aged care facility	Home

*Pseudonyms used.

Three interrelated drivers were identified, each with a further two sub-themes (Figure 1). The drivers and sub-themes were consistent with a theoretical framework (herein referred to as the family caring & health-related outcomes framework) which provides theoretical background for relevant findings (21). The framework proposes four domains that address the effects of family carers on the health-related outcomes of older adult care-recipients in home health care: type of carer (spouse, offspring, relative, non-relative); nature of caregiving relationship (availability, familiarity, motivation, care recipient's preference, burden); type of caregiving (psychosocial vs direct care); and internal processes of the care recipient (psychological, behavioural and physiological processes). These domains are informed by task-specific theory, hierarchical-compensatory theory, burden theory, direct effect theories, and stress-related theories (21).

Responsibility

Agency responsible for providing nutrition support

The researchers considered three candidates who may assume responsibility for providing nutrition support for malnourished older rehabilitation patients: carers, the health service (including rehabilitation dietitian) and the care-recipients.

The high responsibility experienced by the carer in providing nutrition support to the care-recipient was strongly expressed across all interviews. The carers saw nutrition support as one of their key roles, which continued during the rehabilitation admission.

“... we had a picnic the other day outside, and we had salmon rolls, and a banana, no, fruit salad I made him. So when I come I bring something, just to boost what he's getting at present” (T1, Jill, carer for Lester).

This finding illustrates the importance of the nature of the caregiving relationship and the motivation of the carer to provide physical and psychosocial care (21), aligning with the concept that older adults may experience less psychological consequences when care is provided by their preferred person, such as a familiar family carer (21, 22, 23). Interestingly, all carers, at both time-points, recognised that nutrition or eating was a difficulty or problem for their care-recipient, but failed to seek formal nutrition support (24, 25). Although there were multiple reasons why the carers did not seek formal nutrition support in the current study (Table 2), all carers expressed a strong desire to be highly involved in any form of nutrition support that the health service provided to their care-recipient.

“I think it’s awfully important to be involved, particularly if he’s coming home. I’d have to be. That’s, you know, that’s the be all and end all of that. I mean, I’d have to be... I’m buying the food, I’m cooking the food, I’m serving the food... I must be involved in that” (T1, Joan, carer of Alfred).

It was further interpreted that some carers expected that the health service had a responsibility to provide information to the carers about nutrition support services, and likewise the rehabilitation dietitian should have actively sought out and engaged with the carer whenever care was provided to a malnourished patient. Similar studies have found that whilst carers of older adults may receive praise for their caregiving, they are given little practical assistance by health care providers (23-27). Thus, although previous theory has described formal support as the final preference of elderly care-recipients (coming after care provided by family members) (22), it was clear in the current study that carers themselves perceive such formal support as essential to performing their own role as family carers. Carers further expressed that, in their experience, their contribution in providing nutrition support was not recognised by the health service. A model of care focussed only on the partnership between the health professional and the patient may ignore the overlap between professional and family carers, particularly considering that family carers assume primary responsibility for the care-recipient’s overall wellbeing (28).

Finally, carers experienced that the care-recipient themselves assumed low responsibility for their own nutritional status and dietary intake.

“Mum’s always been very aware of nutrition, so it’s been hard to see her like this, in a state that she’s not really... taking care of what she needs” (T1, Amanda, carer of Velma).

“He wouldn’t listen [to nutritional advice]” (T1, Joan, carer of Alfred)

Amanda’s quote represents Velma as undergoing a change in her interest and value in nutrition, and that her current lack of responsibility for her own nutrition support did not reflect her long-term nutrition values in Amanda’s experience. Alternatively, Joan gave her experience of Alfred as having a firm and long-standing disinterest in nutrition advice. Overall, all carers’ experiences were that their malnourished care-recipients assumed low responsibility for their own nutrition, irrespective of the reason, and this is important in understanding why some care-recipients may have poor adherence to nutrition interventions. In addition, the perceived low responsibility assumed by care-recipients was interpreted to

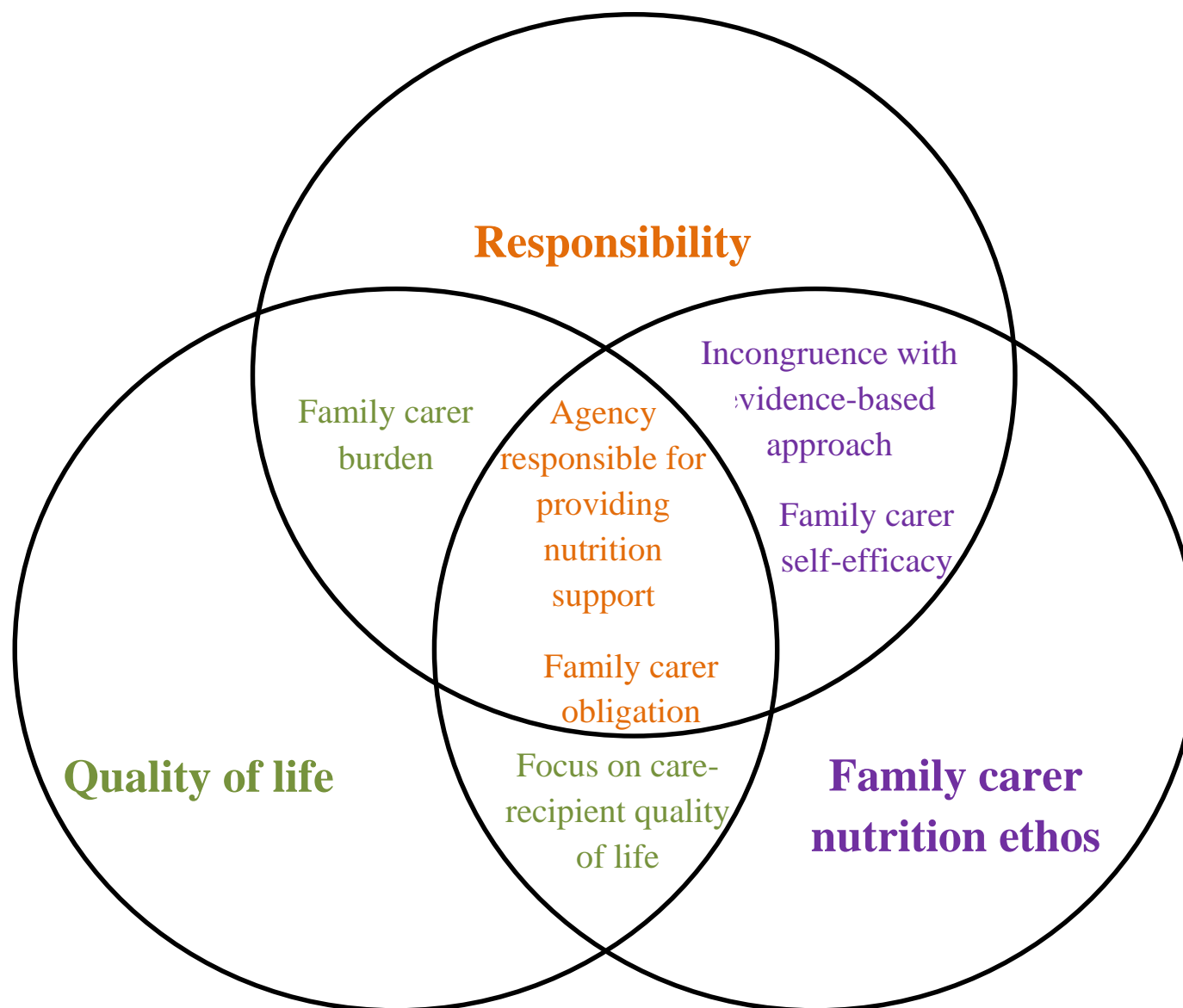


Figure 1: Schematic overview of three interconnected “drivers” and their sub-themes which represent the nutrition and food-related roles, experiences and support needs of female family carers of malnourished older rehabilitation patients.

Table 2: Family carers' reasons for not engaging with formal nutrition support provided by the rehabilitation unit during or after their care-recipients' rehabilitation admission.

Reason	Quote	Details*
Lack of knowledge of any nutrition support services	<i>"Not really aware of any [nutrition services in rehabilitation], apart from, you know, just... I wasn't really aware of any of them"</i>	T1, Amanda, carer of Velma
Belief that if help was needed then the health service would take initiative to intervene and engage the caregiver	<i>"Probably because I don't know enough about a nutritionist, how they would work, it would be something that the hospital would have to talk to us about, or the hospital would refer the nutritionist to us"</i>	T2, Cindy, carer of Leona
Belief the rehabilitation nutrition support services are unable to assist their care-recipient due to inadequate knowledge of the individual	<i>"She eats a lot of fish... they haven't been feeding her fish, and that's all she mainly eats... That is one of the main reasons she's not eating here"</i>	T1, Cindy, carer of Leona
Belief that they have enough knowledge and resources to provide sufficient nutrition support without assistance from formal services	<i>"I sort of feel I understand what's needed... unless I had a problem... when you asked me "would a dietitian help me", I thought I knew it all"</i>	T2, Jill, carer of Lester
Concern over the cost of formal nutrition support services	<i>"But all you think of is "hang on, if I'm going to get a nutritionist, it's going to cost me an arm and a leg"</i>	T2, Cindy, carer of Leona
Failure to recognise malnutrition and need for a specialised dietary approach	<i>"Quite shocked actually [at learning Alfred has malnutrition]. I mean, ah, I suppose he is thin, but I have never known him any other way. I can't say I've looked at Alfred over the last few months even and thought you know, you look thinner than..."</i>	T1, Joan, carer of Alfred

*Pseudonyms used.

impact upon the carers' assumed responsibility for providing nutrition support. Internal processes of a care-recipient, incorporating self-esteem, meaning of life, obligation to life, loneliness and stress have been linked to health care adherence (21) and may provide some insight into the reasons why the care-recipients in the current study were perceived to assume little or no responsibility by their carers.

Family carer obligation

"I find it very hard. I find it very constant. I find him extremely unappreciative. He's eating very well now, good meals, because I'm trying to build him up, because he's going in for the operation to get a TURP [crying]. And he needs to be as strong as he can be... so I'm doing all I can from my side to strengthen him" (T2, Jill, carer of Lester)

This quote exemplifies our interpretation of how the carers' provision of nutrition support was linked to their experience of the care-recipient taking little responsibility, and how this was linked to carer burden (Figure 1). But further than that, we interpreted that Jill's provision of nutrition support was voluntary in some ways (due to the emotional connection with Lester) and involuntary in other ways (due to Lester placing high demands for care on his wife). As discussed earlier, all carers experienced feelings of obligation to provide nutrition support for their care-recipients, but the motivation behind this obligation was diverse, including varying degrees in which this responsibility was voluntarily assumed by the carer. Some carers seemed to naturally assume the responsibility for providing nutrition support on their own volition, whereas others felt this role was involuntarily placed upon them. As the quote by Jill illustrates, the emotion that she expressed revealed how she was personally invested in the wellbeing of Lester. Both Jill and Amanda expressed that, at least partially, they provided their nutrition support out of their feelings of both emotional and self-interested obligation. Because the continued wellbeing of their care-recipients was important to them emotionally, their caregiving was expressed to be more self-initiated and voluntary. Conversely, Cindy expressed her obligation to provide care due to societal and/or legal pressures.

"[if we didn't provide care]...and you know it looks like we're not doing the right thing by her" (T2, Cindy, carer of Leona).

When initially contacted, Cindy was concerned of negative repercussions if the researcher felt her care was inadequate. In this case, the researcher perceived there was less emotional connection to the care-recipient than the other carers, as Cindy had only known Leona for

two years, and her husband (Leona's son) did not have a close relationship with Leona. For Cindy, we interpreted that the provision of care seemed less voluntary than for Amanda and Jill. These findings can be further interpreted by examining the nature of the caregiving relationship, given that the motivations for caregiving may be different depending on the type of carer, such as spouse, offspring or non-relative (21, 30, 31).

Joan did not see herself as a carer, instead stating that her role as a wife had not changed with Alfred's worsening health status. However, Joan had significant support needs herself, which may have contributed to why she did not recognise her caregiving role. Alternatively, Joan may see caregiving as an extension of her spousal relationship, previously proposed to occur as a consequence of wider sociocultural roles (21, 29).

Previous researchers have proposed that spouse carers experience less role strain than daughters, who have a greater burden due to a reversal of roles (21, 30, 31). However, despite the varying origins of carer obligation, all carers expressed their willingness to assume the responsibility for nutrition support. Obligation perceived by the carers was interpreted to differ depending on influences from the other drivers. For example, when providing nutrition support was perceived to have a negative impact on the carers' own quality of life (Figure 1), the less voluntarily, or with a less emotional and self-interested sense of obligation, the care provision seemed. Conversely, other carers tended to be more willing to assume the responsibility, especially if they held a strong nutrition ethos (Figure 1). Aligning strongly with the family caring and health-related outcomes framework (21), quality of the personal relationship between the carer and the care-recipient was identified as a major influence affecting the willingness to provide care, closely aligned with the emotional sense of obligation.

"I've discovered how very much I miss him when he's been away. He's a very big part of my life, and we've been married for 60 years...It is very important to me that he does as well as he can for as long as he can... And him being well fed, and getting strong is a very important part of that, you know" (T1, Jill, carer of Lester).

"She doesn't want to be pushed. Um, as I said, she's a very stubborn lady, but the thing is always "no, whatever you want" (T1, Cindy, carer of Leona).

Family carer nutrition ethos

Family carer nutrition ethos captures the effect of the nutritional values, beliefs and knowledge of the carers on their persistency and the type of nutrition support strategies they

used. Across the interviews, it was observed that the more value the carer placed on nutrition (or a particular nutritional belief), the more persistent, voluntary or proactive they were with the provision of their nutrition support. The type of nutritional belief, and how strongly it was valued, in turn affected the nutritional priorities and strategies employed by the carer.

“It [nutrition] would have to be one of the most important things to me, for me, at this time with my son as well, yeah, very important... I do tend to keep our diet as restrictive of as much dairy as I can, as much wheat as I can, and I’ve just recently become vegetarian and on my way to becoming vegan... [later in the interview] ...so I would like mum to eat kind of more fruit and vegies, you know but she’s not going to, so, there’s not really.. There’s kind of like a bit of a wall with mum” (T1, Amanda, carer of Velma).

However, those who did not hold specific nutritional beliefs or value nutrition as strongly as others saw nutrition support as just another task included as part of their caregiving, and opted for a simple strategy of food provision rather than any particular dietary approach.

“Well as far as value [of nutrition] is concerned, I wouldn’t put anything. You get up, you prepare breakfast, you have something to eat if you’re hungry, you know. I always have plenty of vegetables and stuff” (T1, Joan, carer of Alfred).

“Well, no, he’s eating just the same [as prior to fall and rehabilitation admission]. And I don’t know whether it’s perhaps lack of exercise, you know, that’s making him weak. You see he’s not exercising, he’s not walking... mainly because he can’t” (T2, Joan, carer of Alfred).

This second quote by Joan was interpreted to reflect that she attributed Alfred’s condition to exercise as opposed to dietary intake or nutrition, and did not appear to be highly motivated to provide additional nutrition support despite his continuing malnutrition. However, there may be other reasons Joan was not particularly focused on nutrition support, such as the lack of responsibility and obstinacy against nutrition intervention that Alfred that she had earlier characterised in him.

Family carer self-efficacy

There was a strong impression that all carers felt the nutrition support strategies they provided were sufficient and effective, and that their current level of nutrition knowledge was adequate. This was a contributing factor to the lack of engagement with formal services such as the rehabilitation dietitian (Table 2). However, there was a divergence in self-

efficacy in providing nutrition support overall; specifically for time availability and receptivity of the care-recipient. The two younger generation carers (daughter and daughter-in-law) expressed time and/or distance constraints limited their ability to provide nutrition support; and two carers (daughter-in-law and wife) expressed intransigence of their care-recipients as a limitation. Understanding this finding may be enhanced in the context of the nature of the caregiving relationship which includes availability as a key determinant (21).

“...I worry about her, and worry about finding the time to come up and do a shop with her...” (T1, Amanda, carer of Velma).

“It’s alright for me to go through all these, umm, sort of suggestions, but it’s another thing getting him to follow it. He is a very, very determined man. He will not do anything he does not want to do” (T2, Joan, carer of Alfred)

Nutrition support strategies used by carers were all highly individualised to cater specifically for their care-recipient’s food preferences, lifestyle and culture.

“...when I did do the, looked at the Polish, um, history...And I thought “wow, that’s really different”, here we are trying to introduce a certain type of food to people, and eat breakfast lunch and dinner, they, they don’t do that. And I thought, oh, that’s really interesting, this is probably why she eats when she wants to eat, because yeah there’s no set times...” (Edited text, T1, Cindy, carer of Leona).

The individualised approach used by carers may have led to a high success rate in their provision of nutrition support, in turn contributing to the carers’ self-efficacy, and subsequent concern over the quality of formal support (Table 2). The family caring and health-related outcomes framework (21) supports this finding, where familiarity is shown to impact upon health outcomes through alignment of understanding and lifestyle between the carer and care-recipient. The high self-efficacy of carers facilitated through familiarity may also link with the high responsibility assumed by carers for providing nutrition support discussed earlier.

Incongruence with evidence-based approach

Amanda’s description of her restrictive diet (quoted earlier) demonstrated her strong nutritional belief in the importance of “whole foods”, fruits and vegetables. Although Amanda attached strong values to these foods, all carers believed that a healthy diet with plenty of vegetables was the most important nutritional strategy. This promotion of fruit and vegetables (low-energy and vitamin/mineral-rich foods), whilst a recognised theme, was less

important to the researchers in the analysis than the significance of how this approach does not align with the evidence-based approach for treating malnutrition by promoting energy- and protein-rich foods and beverages (32).

Similarly, of importance to our interpretation within this sub-theme, there was limited discussion about protein during the carer interviews. Jill had the strongest focus on protein, as Lester and Jill had seen a dietitian in acute care where the importance of protein intake was discussed. However, even where the carers recognised the importance of protein, their nutritional knowledge and nutrition support strategies remained inadequate.

“Ah, well, when you asked me “would a dietitian help me”, I thought I knew it all. And further to our discussion I realise that the way I see healthy eating, and the way that Lester needs healthy eating to put on weight, are reversed!” (T2, Jill, carer of Lester).

Quality of life

Focus on care-recipient quality of life

Although the nutrition support strategies described by the carers tended to focus on fruit, vegetables and healthy eating, it was interpreted that the reason behind this was strongly related to quality of life. Carers revealed that their purpose in providing nutrition support was to improve the care-recipients’ overall quality of life, rather than nutritional or medical outcomes.

“If she starts to enjoy life a little bit more, and starts to enjoy this phase of her life, and enjoy her eating...its part of life isn’t it? Not wanting to eat and actually be amongst it and involved...it’s just such a beautiful thing, so, food is such a beautiful thing, so it would be lovely to see her enjoying that” (T1, Amanda, carer of Velma).

The carers also frequently described non-nutrient-related nutrition support strategies which were directly aimed at improving quality of life.

“Try and make the meal time a happy time, and, umm, perhaps add a glass of port! [Laughs] To make it...as pleasant time as you can, because I think that does help the appetite” (T2, Jill, carer of Lester).

Therefore, the care-recipients’ quality of life was seen as both a strategy and an outcome in nutrition support, overall suggesting that nutrition support was approached holistically with a focus upon quality rather than physical outcomes. Literature has shown that carers frequently provide both psychosocial support as well as direct health-related care (21), with

a carer's influence on a care-recipient's health encouraged through psychosocial processes such as promoting positive obligation to life and reduced stress (21).

Family carer burden

The carers' own quality of life was important and diverse, both between carers and within the same carer over time.

"So you know, he's not selfish in that way, he's keen for me to have a life as well. Cause you've got to have a life as well, you know...Even though it might be a tiny bit restricted, it's still a life" (T1, Jill, carer of Lester).

"I find it very hard, very constant...I find him very unappreciative" (T2, Jill, carer of Lester).

Jill conveyed that burden of care significantly increased following Lester's discharge from rehabilitation. However, this was not the case for all carers. Joan did not report increased burden of care; however, she did require significant additional domiciliary and health care support. Amanda did not have the time to visit and assist Velma following her discharge from rehabilitation, but this increased her anxiety regarding her mother as she desired to be able to provide more care. Cindy reported a significant increase in quality of life following Leona's discharge from rehabilitation; however, unlike the other care-recipients, Leona was not discharged home as originally planned, but instead discharged to a residential aged care facility.

"Exactly, and this is why like carers end up themselves becoming very sick...this is why really the carers need looking after in their nutritional... you know, not just nutrition but just being able to have that respite, that care... [later in interview]...I've got freedom now!...I don't have to worry" (T2, Cindy, carer of Leona).

Educating family carers of malnourished older adults has been previously shown to improve patient outcomes but have no effect on carer burden (10). The current study provides insight on why this may be the case; as all carers were already assuming the responsibility for nutrition support and wanted to be involved in any formal nutrition support provided to their care-recipient. However, this does not imply that the carer burden is low, as there is good research showing that carers of frail or malnourished older adults have a significant burden of care leading to a lower quality of life (33-35).

Implications for research and practice

Broadly, the findings of this study challenge current practice with the nutrition and dietetic care process (36, 37). It suggests that the way care is delivered in rehabilitation facilities for older malnourished patients should change through the integration of formal and family nutrition support, across both the wider rehabilitation unit and dietetic services. The suggestions for practice described here have been specifically linked to the study findings in the Online Supplementary Material 3.

Within rehabilitation units, system changes are required to ensure family carers are aware of the nutrition support resources available to them, and are assisted to access these services. Specifically for dietetic practice, dietitians should identify and deliberately engage family carers of malnourished patients and recognise that the care-recipient themselves may assume less responsibility for their nutritional intake than the carers. Additionally, dietitians should understand carer nutritional beliefs and the types of nutrition support strategies used by the carer, as well as the motivations behind them, in order to make more carer-centred recommendations and correct inappropriate nutrition strategies. Such strategies should still acknowledge the cultural background and food preferences of their patients, in order to provide individualised medical nutrition therapy. In developing strategies, an understanding of the current caregiving concerns of the family carer and joint problem solving is required, so that strategies can be needs-based and provide a meaningful contribution to the pre-existing family carer–care-recipient partnership. Finally, dietitians should recognise that family carers may focus their care upon improving the quality of life of their care-recipients rather than improving nutritional or clinical outcomes. This focus on quality of life should be incorporated in strategies to improve their acceptability to the family carer. Whilst these suggestions may improve practice, further research and evidence is required to develop the evidence base. In order to support the transition of these suggestions to evidence-based recommendations, intervention studies are needed to determine if the proposed coordination of efforts of the rehabilitation dietitian, the carer and the patient will increase the efficacy of nutrition support. The findings of this study suggest that such research should consider not only patient outcomes, but also outcomes in the carer. Finally, further qualitative studies should explore the experiences of male carers of malnourished older adults in rehabilitation, as well as carers in other settings, to better improve understanding.

Limitations

The interviews by the four participants in this study offered rich and diverse themes for exploration and analysis by the researchers; however, the unexpected shorter length of interviews, particularly T2, and lack of data on the severity of malnutrition of the care-recipient are limitations. In addition, due to the purpose of the study, only those themes which were related to the research question were pursued.

Finally, as with all qualitative research there is potential for bias as a result of the researchers' professional, clinical and personal backgrounds, all of whom were Accredited Practising Dietitians. Reflexivity was used throughout the analysis process and in reporting the results in this manuscript to acknowledge this.

Conclusion

“Responsibility”, “family carer nutrition ethos”, and “quality of life” were identified as three drivers of female family carers of malnourished older rehabilitation patients. Rehabilitation units and rehabilitation dietitians should recognise and support family carers of malnourished patients during and after the patients' rehabilitation admission, which may lead to improved patient outcomes and perceived benefit of care. Interventional research is required in order to make strong recommendations for practice.

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Transparency Declaration

The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported, that no important aspects of the study have been omitted and that any discrepancies from the study as planned (and registered with) have been explained. The reporting of this work is compliant with RATs (38) guidelines.

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Online Supplementary Material 1: The MARRC Study interview schedule during rehabilitation (T1)

Values, beliefs and knowledge of caregiver	<ul style="list-style-type: none"> • What value do you place on nutrition in your own health? • What comes to mind when you hear the word “malnutrition” • What is the biggest food related concern you have for your friend/relative/spouse currently? • What experience have you had with dietitians? • What experience have you had with nutrition supplements? • What tips or advice would you share with someone in a similar situation as you to help support the nutrition of your friend/relative/ spouse?
Experience of caregiver at home	<ul style="list-style-type: none"> • How do you feel about your role as a caregiver in general? • What has been your experience in providing or preparing food for your friend/relative/ spouse prior to their current stay in rehabilitation? • How do you think your role as a caregiver will change when your friend/relative/ spouse is discharged home? • Once your friend/relative/ spouse is discharged home, what support would you like to receive from dietitians? • What method of contact would you prefer a dietitian uses to support you once your friend/relative/spouse is discharge home?
Experience of caregiver in rehabilitation	<ul style="list-style-type: none"> • What are the nutrition services you know exist in rehabilitation? • What value do you place on nutrition to support your friend/relative/ spouse through their current stay in rehabilitation? • How involved would you like to be in the nutrition support of your friend/relative/ spouse during their stay in rehabilitation? • How do you feel about your friend/relative/ spouse’s diagnosis of malnutrition? • What help or support do you want from nutrition services in hospital or rehabilitation?

a. The interview schedule served as a guide and was not prescriptive in the order or wording of questions.

Online supplementary material 2: The MARRC Study interview schedule post-rehabilitation (T2)

Reflection of experience of caregiver in rehabilitation	<ul style="list-style-type: none"> • What value do you place on nutrition for patients in rehabilitation? • What nutrition services or support did you have during your friend/relative/ spouse's rehabilitation stay? • How do you feel about your caring role during your friend/relative/ spouse's rehabilitation stay?
Experience of caregiver following discharge	<ul style="list-style-type: none"> • How has your role as a caregiver will changed since your friend/relative/ spouse finished rehabilitation? • What is the biggest food related concern you have for your friend/relative/spouse currently? • What has been your experience in providing or preparing food for your friend/relative/ spouse since rehabilitation?
Support needs and preferences of caregiver	<ul style="list-style-type: none"> • What tips or advice would you share with someone in a similar situation as you to help support the nutrition of your friend/relative/ spouse? • What support, if any, would you like to receive from dietitians now you're your friend/relative/ spouse has been discharged from rehabilitation? • What method of contact would you prefer a dietitian uses to support you once your friend/relative/spouse is discharge home?

a. The interview schedule served as a guide and was not prescriptive in the order or wording of questions.

Online supplementary material 3: The MARRC Study findings which support the suggestions for nutrition and dietetics practice in rehabilitations units.

Suggestion for practice	Findings of the drivers and subthemes which support the suggestion for practice
<p>Rehabilitation units should ensure family carers are aware of the nutrition support resources available to them, and have assistance in accessing these services</p>	<ul style="list-style-type: none"> · “The carers saw nutrition support as one of their key roles, which continued during the rehabilitation admission” (Agency responsible for providing nutrition support) · “All carers expressed a strong desire to be highly involved in any form of nutrition support that the health service provided to their care-recipient” (Agency responsible for providing nutrition support) · “All carers, at both time-points, recognised that nutrition or eating was a difficulty or problem for their care-recipient, but failed to seek formal nutrition support” (Agency responsible for providing nutrition support) · “Family carers’ reasons for not engaging with formal nutrition support provided by the rehabilitation unit during or after their care-recipients rehabilitation admission: Lack of knowledge of any nutrition support services; Belief that if help was needed then the health service would take initiative to intervene and engage the caregiver; Concern over the cost of formal nutrition support services” (Table 2, Agency responsible for providing nutrition support) · “It was further interpreted that some carers expected that the health service had a responsibility to provide information to the carers about nutrition support services” (Agency responsible for providing nutrition support)

	<ul style="list-style-type: none"> · “Carers further expressed that, in their experience, their contribution in providing nutrition support was not recognised by the health service” (Agency responsible for providing nutrition support)
Dietitians should identify family carers of malnourished patients, and actively seek out and engage with them	<ul style="list-style-type: none"> · “The carers saw nutrition support as one of their key roles, which continued during the rehabilitation admission” (Agency responsible for providing nutrition support) · “All carers expressed a strong desire to be highly involved in any form of nutrition support that the health service provided to their care-recipient” (Agency responsible for providing nutrition support) · “All carers, at both time-points, recognised that nutrition or eating was a difficulty or problem for their care-recipient, but failed to seek formal nutrition support” (Agency responsible for providing nutrition support) · “It was further interpreted that some carers expected that ...the rehabilitation dietitian should have actively sought out and engaged with the carer whenever care was provided to a malnourished patient” (Agency responsible for providing nutrition support) · “Carers further expressed that, in their experience, their contribution in providing nutrition support was not recognised by the health service” (Agency responsible for providing nutrition support) · “Family carers’ reasons for not engaging with formal nutrition support provided by the rehabilitation unit during or after their care-recipients rehabilitation admission: Lack of knowledge of any nutrition support services; Belief that if help was needed then the health service would take initiative to intervene and engage the caregiver; Failure to recognise malnutrition and need for a specialised dietary approach” (Table 2, Agency responsible for providing nutrition support)

	<ul style="list-style-type: none"> · “All carers expressed their willingness to assume the responsibility for nutrition support” (Family carer obligation)
Dietitians should recognise that malnourished patients may assume low responsibility for their own nutrition support, but that their family carers may assume high responsibility for their care-recipients’ nutrition support	<ul style="list-style-type: none"> · “The high responsibility experienced by the carer in providing nutrition support to the care-recipient was strongly expressed across all interviews” (Agency responsible for providing nutrition support) · “There was a sense that all carers experienced that the care-recipient themselves assumed low responsibility for their own nutritional status and dietary intake” (Agency responsible for providing nutrition support) · “Some carers seemed to naturally assume the responsibility for providing nutrition support on their own volition, whereas others felt this role was involuntarily placed upon them” (Family carer obligation)
Dietitians should discuss the nutrition ethos of family carers to understand the types of nutrition support strategies used, and the motivations behind them, in order to make more carer-centred recommendations and/or identify and correct inappropriate nutrition strategies	<ul style="list-style-type: none"> · “Other carers tended to be more willing to assume the responsibility [of providing nutrition support], especially if they held a strong nutrition ethos” (Family carer obligation) · “It was observed that the more value the carer placed on nutrition (or on a particular nutritional belief), the more persistent, voluntary or proactive they were with the provision of their nutrition support. The type of nutritional belief, and how strongly it was valued, in turn affected the nutritional priorities employed by the carer” (Family carer nutrition ethos) · “All carers believed that a healthy diet with plenty of vegetables was the most important nutritional strategy...this approach does not align with the evidence-based approach for treating malnutrition by promoting energy- and protein-rich foods and beverages” (Incongruence with evidence-based approach)

	<ul style="list-style-type: none"> · “Even where the carers recognised the importance of protein, their nutritional knowledge and nutrition support strategies remained inadequate” (Incongruence with evidence-based approach)
When arranging nutrition support strategies, dietitians should investigate the current caregiving concerns of the family carer and utilise joint problem solving, so that their strategies can be needs-based and provide a meaningful contribution to the pre-existing carer–care-recipient partnership	<ul style="list-style-type: none"> · “Nutrition support strategies used by carers were all highly individualised to cater specifically for their care-recipient’s food preferences, lifestyle and culture” (Family carer self-efficacy) · “The carers’ own quality of life was important and revealed to be diverse” (Family carer burden) · “Family carers’ reasons for not engaging with formal nutrition support provided by the rehabilitation unit during or after their care-recipients rehabilitation admission: Belief that they have enough knowledge and resources to provide sufficient nutrition support without assistance from formal services” (Table 2, Agency responsible for providing nutrition support)
As per best-practice, dietitians should explore and acknowledge the cultural background and food preferences of their patients, in order to provide individualised medical nutrition therapy	<ul style="list-style-type: none"> · “Nutrition support strategies used by carers were all highly individualised to cater specifically for their care-recipient’s food preferences, lifestyle and culture” (Family carer self-efficacy) · “Family carers’ reasons for not engaging with formal nutrition support provided by the rehabilitation unit during or after their care-recipients rehabilitation admission: Belief the rehabilitation nutrition support services are unable to assist their care-recipient due to inadequate knowledge of the individual” (Table 2, Agency responsible for providing nutrition support)

<p>Dietitians should recognise that family carers may focus their care upon improving the quality of life of their care-recipients rather than improving nutritional or clinical outcomes. This focus on quality of life outcomes should be incorporated as strategies and motivations to improve acceptance by the family carer.</p>	<ul style="list-style-type: none"> · “Carers revealed that their purpose in providing nutrition support was to improve the care-recipients’ overall quality of life, rather than nutritional or medical outcomes (Focus on care-recipient quality of life) · The carers also frequently described non-nutrient-related nutrition support strategies which were directly aimed at improving quality of life” (Focus on care-recipient quality of life) · “Family carers’ reasons for not engaging with formal nutrition support provided by the rehabilitation unit during or after their care-recipients rehabilitation admission: Failure to recognise malnutrition and need for a specialised dietary approach” (Table 2, Agency responsible for providing nutrition support)
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7.1.3 Statement of contribution

Skye Marshall carried out the data collection, conducted the analysis and interpretation of data, and drafted the manuscript. Elizabeth Isenring and Dianne Reidlinger contributed to data analysis. Skye Marshall, Dianne Reidlinger, Adrienne Young and Elizabeth Isenring contributed to the study concept and revision of the manuscript.

7.1.4 Conclusion

With an increasing preference for independent living as opposed to RACFs in ageing populations, the influence of informal caregivers on the health of the older adult must be acknowledged. From a nutrition perspective, duties of care often involve shopping, meal preparation and/or assistance with eating. This will in turn impact upon the nutrition-related health outcomes in older adults.

This study aimed to determine the nutrition and food-related roles, experiences and support needs of female informal caregivers of malnourished older adults admitted to rehabilitation units in rural NSW, Australia, both during admission and following discharge to the community. The findings of this study were found to align with a proposed theoretical framework (referred to as the family caring & health-related outcomes framework in the manuscript) which proposes four domains that address the effects of family carers on the health-related outcomes of older adult care-recipients in home health care (Cho, 2007). The domains (type of carer, nature of caregiving relationship, type of caregiving and internal processes of the care recipient) are informed by task-specific theory, hierarchical-compensatory theory, burden theory, direct effect theories, and stress-related theories (Cho, 2007). This framework was used to help inform the interpretation of the drivers and sub-themes of the qualitative investigation.

This study found that female informal caregivers of malnourished older adults assumed high responsibility for the provision of nutrition support to their care-recipients. This support continued even during the rehabilitation admission, where they did not actively seek formal nutrition support. However, the caregivers wanted to be engaged in formal nutrition support if it was offered to their care-recipients. Furthermore, the caregivers did not feel that their care-recipients assumed responsibility for themselves during rehabilitation or in the first two weeks post-discharge.

The caregivers' nutrition ethos significantly impacted upon the persistency and type of nutrition support they provided. The caregivers' generally had high self-efficacy in their

delivery of this nutrition support; however, their strategies were incongruent with the evidence-based approach for treating malnutrition.

The caregivers considered quality of life to be of significant importance in their caregiving, not only as a strategy and outcome of nutrition support, but also for the impact that caregiving had upon their own lives. The implications for practice are described in detail in the manuscript and online supplementary table 3, but overall recommend the integration of formal and informal nutrition support in rehabilitation units. This will ensure support for informal caregivers of malnourished patients, which may ultimately lead to improved patient outcomes and perceived benefit of care. The suggestions for practice and research in this study can be used to design a nutrition intervention study, which may be used to inform practice.



PART IV

CONCLUSION

CHAPTER 8

CONCLUSIONS AND IMPLICATIONS OF FINDINGS

8.1 Conclusions

The aim of this thesis was to “*increase the evidence-base for improving the nutrition status of older adults in rural Australia across the continuum of care and exploring the role of caregivers in supporting nutrition-related care during the transition from rehabilitation to home*”. Evidence-based practice requires that all nutritional problems must be addressed through the application of the nutrition care process (appendix III) (Lacey & Prichett, 2003). However, the exact way the nutrition care process is applied in each setting and each patient requires its own evidence base. This thesis identified that there is currently significant evidence gaps in the nutrition care process in the rehabilitation setting, particularly relating to malnutrition identification, the nutrition care team and post-discharge nutrition support (chapters 2.5, 2.6, 2.7, 4.2 and 5.4). Therefore, this thesis aimed to close these gaps. The current thesis has contributed significant understanding of the transition of malnourished older adults from rehabilitation to the community in rural Australia, and how to engage informal caregivers to support this process. It has also provided significant improvements in the evidence for nutrition screening and nutrition assessment in rehabilitation, so that overall patient outcomes can be improved through enhanced identification of patients in need. It has exposed areas for further research, which will strengthen its preliminary findings.

An overview of how the research conducted as part of this thesis has contributed towards meeting its aim has been presented in the outline of the thesis (chapters ix, x, xi and xii in the preliminary pages). This chapter will outline the novelty, limitations and significance of the research presented in this thesis, as well as a discussion of the implications for practice, research and policy.

8.1.1 Summary of novel contributions

This thesis presents the first work to integrate malnutrition research across the rehabilitation and community settings, and is also the first to examine the role of informal caregivers in regards to malnutrition in these settings. This work also presents significant novel findings to the general malnutrition literature through the examination of malnutrition in the rural context, an area little explored internationally. Further to this, the impact of acute care and RAC upon the older malnourished patient were acknowledged and briefly examined, as a malnourished older adult may move across these four settings within a short period of time. Although there are many novel findings reported throughout the seven publications included in this thesis, the most significant is that nutrition support in rural rehabilitation facilities is not currently effective in improving the nutrition status

of older adults, and therefore these malnourished older adults have poor health-related outcomes in the long term (Marshall et al., 2014; Marshall et al., 2015). Overall, this means that these older adults are more likely to be admitted to RAC instead of remaining in their homes following their rehabilitation admission, and they remain at risk of malnutrition or malnourished even when they receive high level care in RACFs (appendix IV) (Agarwal et al., 2016).

Therefore, the research presented in this thesis supports the conclusion of the Productivity Commission, that Australia's aged and health care system is not currently able to meet the challenges of the ageing population (2011b; 2012a). Although the Australian government has made significant progress in their "Living Longer, Living Better, Aged Care Reform Package" (2012c), providing funding to support older adults to remain in their own homes will be moot if older Australians do not have sufficient physical independence to live at home. However, this thesis has identified opportunities to improve outcomes for older adults. It suggests that the provision of sufficient nutrition support in the rehabilitation and community settings, and the engagement of informal caregivers as part of the care team may be a clinically effective and cost-effective strategy to prevent and treat malnutrition in the rehabilitation community (unpublished data, 2016; chapter 7.1.2) (Marshall et al., 2013; Marshall et al., 2015, 2016a).

The novel contributions to the evidence for applying the nutrition care process in rehabilitation and the post-rehabilitation settings are discussed here.

8.1.1.1 Nutrition screening

Nutrition screening is essential so that a patient may be engaged in the nutrition care process. The method of nutrition screening must have high validity to ensure patients at risk of malnutrition are not overlooked, but also that resources are not misused by overestimation of risk. The research presented in this thesis suggests that the MST, previously unstudied in the rehabilitation setting, had a higher sensitivity and specificity than the commonly used MNA-SF when compared to hospital coding criteria (ICD-10-AM) (Marshall et al., 2016b). In addition, it is the only nutrition screening tool with sufficient validity when compared to a suitable multidimensional benchmark (Marshall, 2016). This thesis also included the first comprehensive review of the criterion validity of all nutrition screening tools which have been evaluated in the rehabilitation setting. This considerably improves the dissemination of validity studies to assist practitioners in selecting the appropriate nutrition screening tool for their patient group (Marshall, 2016).

8.1.1.2 Nutrition assessment and diagnosis

Once a patient is identified as at risk of malnutrition, they are engaged in the nutrition care process, which begins with nutrition assessment. Following nutrition assessment, a nutrition diagnosis is made, and although nutrition assessment is commonly completed in all rehabilitation facilities internationally, there has not been sufficient research validating nutrition assessment tools in this setting. The research presented in this thesis provides the first robust evaluation of the criterion validity of two nutrition assessment tools, and found that the Scored PG-SGA has strong validity in this setting, and is able to predict patient outcomes (Marshall et al., 2016a). This was the first study to evaluate the Scored PG-SGA in an older adult sample, and found that a lower cut-off value in the continuous score, used to indicate critical need for intervention, should be used when applying the Scored PG-SGA to rehabilitation patients over 65 years.

The study also found that although the MNA was able to predict patient outcomes, underdiagnosed malnutrition (score of <17 to indicate malnutrition), a finding which was also reported by several other studies identified in the narrative review (Marshall, 2016; Marshall et al., 2016a). In addition, this validity study was the first to report the malnutrition prevalence in any rural population. Somewhat surprisingly, the prevalence was comparable to Australian urban areas despite decreased access to health services. However, attrition due to institutionalisation and mortality was higher in the rural population than those reported in urban areas, which may be a reflection of the decreased access to health services (Marshall et al., 2016a). This thesis also reports the first comprehensive and detailed review of malnutrition prevalence which included descriptions of geographical location, patient characteristics and the method of diagnosis. This study found that Australia has one of the highest reported malnutrition prevalence internationally (Marshall, 2016).

8.1.1.3 Nutrition intervention and monitoring

Nutrition intervention follows the nutrition diagnosis. Nutrition intervention should then undergo monitoring and evaluation, which completes the nutrition care process. This study found that the Scored PG-SGA can be used to monitor change in nutrition status during a short period of time (≥ 6 days), and can therefore monitor the effect of nutrition interventions (Marshall et al., 2016a).

Overall, this thesis found that “usual care”, including current standard nutrition intervention by the rehabilitation dietitian, was unable to improve nutrition status during

rehabilitation in rural NSW (Marshall et al., 2015). The systematic review (chapter 4.2.2) also suggests that standard practice is unable to significantly improve patient outcomes internationally, as malnourished patients had poorer outcomes post-discharge. Although, as post-discharge nutrition status had not been measured by any study prior to the MARRC study, it is unknown if the patient remained malnourished after receiving standard care in rehabilitation (Marshall et al., 2014).

The systematic review conducted in the community setting found that engaging informal caregivers as part of the nutrition care team is effective in improving the nutrition status of malnourished older adults, without increasing carer burden (Marshall et al., 2013). The qualitative study reported in chapter 7.1.2 makes suggestions for how informal caregivers can be engaged in the inpatient rehabilitation setting. Specifically, rehabilitation units and rehabilitation dietitians should recognise and support informal caregivers of malnourished patients, aiming to integrate formal and informal nutrition support.

As the participants in the MARRC study all had informal caregivers, there was potential for the caregivers to be engaged by the rehabilitation facilities, which may have improved the nutrition status of the patients. However, the informal caregivers were not engaged. The findings of this thesis show that older Australians in rural areas are not nutritionally supported in their transition from rehabilitation to home. This is not ethically acceptable, and is likely to cause further burden for the patient, the health care system and the aged care system.

Overall, this thesis concludes with a question: *why?* Why is current nutrition support for malnourished rehabilitation patients not leading to improved patient outcomes? This thesis suggests that malnutrition is not a priority on the rehabilitation agenda. This is reflected initially by the limited intervention research conducted in this setting; but perhaps more importantly, by the fact that dietetic staffing levels are inadequate in Australia (chapter 5.3.5) (Barrett et al., 2015). Therefore, not only do we need to improve the evidence-base for the treatment of malnutrition across the continuum of care, advocacy is needed for malnutrition, and nutrition more broadly, to be of higher consideration for rehabilitation policy makers and enforcers.

8.1.2 Limitations of the current research

8.1.2.1 Research quality

The first four chapters of this thesis comprise a thorough literature review regarding malnutrition in the Australian context across the continuum of care, with emphasis on the

rehabilitation and community settings. However, despite the depth of the narrative reviews (chapters 1, 2 and 5.4; appendix V) and the thorough approach used in the systematic reviews (chapters 3 and 4); overall, the findings are limited by the very few intervention studies identified, particularly the lack of RCTs. The chapters of this thesis mostly comprise a description the current situation through the assemblage of observational research. The exception is the narrative review of nutrition interventions in the RAC setting (chapter 2.7.3; appendix V) and the systematic review presented in chapter 3.2 (Marshall et al., 2013). However, both these reviews of intervention studies include only a small number of heterogeneous intervention papers and are therefore limited in scope and significance. Overall, the current observational and interventional research in the field of malnutrition is weakened by researchers failing to report interventions or standard practice fully, failing to use a validated method of malnutrition diagnosis and failing to measure long-term and/or clinically relevant outcomes (chapters 2.7.3, 3.2.4 and 4.2.5). Increased use of reporting guidelines, such as TIDieR (Template for Intervention Description and Replication; for interventional studies) and STROBE (STrengthening the Reporting of OBservational studies in Epidemiology; for observational studies) can help to overcome these limitations in future publications (Hoffmann et al., 2014; Von Elm et al., 2007).

The MARRC study described in this thesis includes similar limitations in that it does not contribute to the intervention research on malnutrition in the rehabilitation community. However, due to the lack of observational studies in this area (particularly in the rural setting), it provides the necessary first step so that high quality interventions studies may follow. Although the thesis does not provide answers about the effectiveness of nutrition intervention which integrates informal caregivers as part of the nutrition care team, the research conducted as part of the thesis provides strong evidence for pursuing this line of enquiry, with the qualitative study (chapter 7.1.2) providing clear suggestions as to how this intervention should be designed.

8.1.2.2 Sampling, bias and generalisability

Although the MARRC study fills a significant gap in the evidence-base for malnutrition in older adults in the rehabilitation community, and all studies are adequately powered statistically, the findings are still limited by the smaller sample size of 30 and 57 participants (Marshall et al., 2015, 2016a, 2016b). Although larger samples would lend confidence to the results, this is often harder to achieve in both rural and malnourished prospective samples. As inclusion criteria were as broad as possible and all potentially eligible patients were invited to participate using consecutive sampling, the smaller sample

size in the MARRC study was likely due to a comparatively low patient turnover in rural rehabilitation units, related to the longer length of stay compared to acute care. However, in similar prospective studies, malnourished patients tended to have a high non-response rate (50 – 80%), (Neumann et al., 2005; Neumann et al., 2007), leading to significant consent bias. This may be due to the most unwell patients being the least likely to consent to additional health care participation, which in turn means that the data may not be an accurate reflection of the patient experience. However, the MARRC study had only one participant decline participation (98% response rate). This lends significant strength to the findings despite a smaller sample size. Furthermore, it is not uncommon for validity studies (chapters 5.2 and 5.3) to have a smaller sample size, provided the data is sufficiently powered (Bauer et al., 2005; Isenring et al., 2006; Stratton et al., 2004).

Although the MARRC study is not affected by consent bias, and selection bias was minimised through consecutive sampling, the data may have been affected by observer bias as only one researcher collected and analysed the data, with no blinding of participants. As this risk of observer bias was known prior to study implementation, strategies were employed to reduce its impact. These included selecting objective outcome measures as much as possible, using consistent methods in data collection and recording, participation in training of data collection, having an independent expert (EI) check the accuracy of data collection tools, data checking, and liaising with an independent statistician to ensure data was handled and analysed correctly.

The prospective cohort study described in chapter 6 was affected by attrition bias. This cohort had a higher rate of attrition than expected due to institutionalisation and mortality, and therefore 43% did not attend post-discharge assessment. Interestingly, the cohort showed a slight (but not statistically significant) improvement in physical function (Modified Barthel Index score improved from 74.5 ± 23.0 to 78.9 ± 18.1) following discharge from rehabilitation to home (Marshall et al., 2015). Post-hoc analysis revealed this was due to attrition bias. The participants with the lowest physical function were those that were admitted to an RACF or died, and therefore, those with better physical function remained in their homes and attended assessment. Investigation of the Modified Barthel Index category agreed with this finding, where there was a downward trend in physical function for 15 of the 17 participants who attended the follow-up assessment. As malnutrition is associated with poor physical function, this suggests that those participants who did not attend the follow-up assessment were likely to be malnourished, either in the RACF or up

until their death. Therefore, although the sample was affected by attrition bias, this is actually a clinically relevant finding due to the cause of attrition.

The interviews by the four participants in the qualitative study (chapter 7.1.2) offered rich and diverse themes for exploration and analysis by the researchers; however, due to the purpose of the study, only those which were related to the food- and nutrition-related roles, experiences and support needs of the caregivers were pursued. This has provided significant advantage to the rehabilitation dietitian, as it has provided valuable suggestions for practice and further interventional research. But it should also be acknowledged that important themes were not identified because they were not related to the specific purpose of this study. While recruiting only female informal caregivers allowed for synthesis of experience by producing a homogenous sample, it should also be acknowledged that the roles, experiences and needs of male caregivers may differ, and suggestions for practice and future research are likely to have differed in some ways. As the majority of informal caregivers are females (70% of primary caregivers in Australia) (2012e; Van Houtven et al., 2013), the current suggestions for practice may be more relevant clinically, but in time both genders need to be represented in the research. Finally, the bias likely introduced by the researchers professional and clinical backgrounds, as well as personal biases should also be acknowledged as a potential limitation upon the analysis and discussion of the drivers and sub-themes. However, this is a well acknowledged limitation across all qualitative research.

Finally, although the MARRC study presents many significant and novel findings, the generalisability of these findings to other patient groups must be considered by clinicians and policy makers. The samples are well described in the publications (chapters 5.2.2, 6.1.2 and 7.1.2) to increase understanding of where the results may be relevant for other patient groups. The study cohort was sampled from two public rural rehabilitation units in eastern NSW, each with a catchment area up to 150km in diameter. Therefore, the sample should be representative of rural NSW in general, and likely most of rural coastal Australia. However, results should be interpreted with more caution for remote, inland or metropolitan areas of Australia, and especially for international patient groups. This highlights the importance of further research in this area, both observational and intervention, in diverse patient groups to improve the evidence for how to best support malnourished older adults across the continuum of care.

8.2 Implications of findings

8.2.1 Implications for practice

This thesis, and its seven publications in particular, has presented research with important implications for practice. To enhance clarity, these have been discussed and then summarised in dot point, according to the nutrition care process.

8.2.1.1 Nutrition screening

Identifying malnourished older adults who live at home is challenging, as there is no opportunity for them to regularly engage with any nutrition services and have their nutrition status assessed. Therefore, working with community-based agencies who regularly visit older adults in their homes provides one of the best opportunities to identify community-dwelling malnourished older adults. The systematic review presented in chapter 3.2.2 suggests that private practice and community dietitians should build working relationships with community agencies such as those that provide nursing or domiciliary care. Dietitians should provide training to the staff of these agencies regarding the implementation of nutrition screening tools and referral systems.

Chapter 5.2.2 describes a validity study examining two nutrition screening tools in geriatric rehabilitation, the MST and MNA-SF. As these tools are used frequently by practitioners in this setting, the conclusions of this study are highly significant for clinical dietitians and rehabilitation unit managers. Although the MNA-SF is widely used internationally, this study found that it significantly overestimated the risk of malnutrition in this sample when compared to hospital coding standards for malnutrition. In well-resourced rehabilitation facilities with sufficient dietetic staffing, this may be an appropriate nutrition screening tool so that not only are malnourished patients identified and treated, but also so that malnutrition can be prevented in patients who are at risk but not yet malnourished. However, most rehabilitation units in Australia do not have adequate dietetic staffing (Barrett et al., 2015), as was the case with the sampled rehabilitation units. In under-resourced rehabilitation units, the severe overestimation of malnutrition risk by the MNA-SF places an impractical burden on dietetic staff, as each patient identified will require a full nutrition assessment.

In the latter scenario, the MST was found to be more suitable as it met *a-priori* values for sensitivity and specificity, which increases the chance only patients who require immediate nutrition intervention are identified. This assists clinical dietitians with triage, so that they may provide nutrition assessment for patients who are likely already malnourished. However, it should be noted that neither the MST nor the MNA-SF were able to predict

patient outcomes, showing they are not able to sufficiently identify the patients who will require nutrition intervention. This finding supports the nutrition care process (appendix III), which recommends that nutrition screening must be followed by a full nutrition assessment by a dietitian.

If the MNA-SF is selected by a rehabilitation institution or practitioner, perhaps a lower cut-off value to determine risk of malnutrition may be applied. For example, this may be preferable in under-resourced rehabilitation units which use the full MNA as the preferred nutrition assessment tool, as the MNA-SF forms the first six items of the full MNA. However, other considerations must be made, which includes the fact that the MNA-SF cannot be used in patients under 65 years, the need to obtain anthropometric measures such as weight and height or calf circumference, and the need to perform calculations (BMI) (Kaiser et al., 2009). Overall, this leads to the six-item MNA-SF having a longer implementation time in comparison to shorter nutrition screening tools such as the MST (two items).

The MST has the benefit of being relatively quick and simple to implement with no need to obtain anthropometric measures or to perform calculations. In addition, it may be applied to adult and geriatric populations. However, the MST does not form part of a nutrition assessment tool. Furthermore, due to the short implementation time, it may increase the risk of social desirability bias, where the patient provides a quick answer without much investigation by the person implementing the tool. Further research using a pragmatic approach where non-dietetic staff complete the screening tools would further explore the application of these screening tools in geriatric rehabilitation.

The narrative review reported in chapter 5.4.2 found that there have been eight nutrition screening tools evaluated for criterion validity in the rehabilitation setting. Of the eight nutrition screening tools, only the MST, MUST, SNAQ and SNAQ⁶⁵⁺ met *a-priori* values for concurrent validity; however, only the MST was compared to a suitable multidimensional benchmark to identify malnutrition. Therefore, currently the MST has the strongest evidence for use in geriatric rehabilitation; however, the MUST, SNAQ, SNAQ⁶⁵⁺ and the Rapid Screen (which was close to meeting *a-priori* values) may also be suitable, but require further research to confirm their accuracy in identifying risk of malnutrition. The narrative review also confirms the conclusion of the validity study reported in chapter 5.2.2; specifically, that the MNA-SF overestimates risk of malnutrition in geriatric rehabilitation, and confirms that it is not currently suitable for most

rehabilitation facilities due to the negative impacts upon nutrition resources, such as dietetic staffing. Furthermore, the review confirms that both nutrition screening tools and the BMI are not sufficiently accurate in identifying malnutrition, and therefore dietitians should follow nutrition screening with a full nutrition assessment.

The prospective cohort study reported in chapter 6.1.2 revealed how patients admitted to rehabilitation remained malnourished at discharge; however, throughout the rehabilitation admission only 50% of the patients had been identified as malnourished and referred to the dietitian. This reveals that the sampled rehabilitation units may have benefited from re-screening patients (via the MST in this case) regularly and/or staff require further and ongoing training in the correct implementation of nutrition screening tools.

These recommendations for nutrition screening are summarised as:

- Community and private practice dietitians should build relationships with community care organisations which provide domiciliary or health care to older adults living in their own homes. The community and private practice dietitians should provide in-service education regarding malnutrition and nutrition screening, and the community care organisations should refer clients at risk of malnutrition to the dietitian for outpatient or home visit consultations (Marshall et al., 2013).
- Rehabilitation units and dietitians should use the MNA-SF to screen for malnutrition in well-resourced rehabilitation units which are focussed upon both preventing malnutrition and treating patients with existing malnutrition (Marshall et al., 2016b).
- Rehabilitation units and dietitians should use the MST to screen for malnutrition in rehabilitation units with limited nutrition resources, in patients <65 years, and in facilities which are focussed upon identifying and treating existing malnutrition (Marshall et al., 2016b).
 - The MUST, SNAQ, SNAQ⁶⁵⁺ and Rapid Screen may also be suitable as nutrition screening tools for this setting; however, require further evaluation of their validity before they can be used confidently (Marshall, 2016).
- The BMI as a single parameter should not be used for screen for malnutrition (Marshall, 2016).
- All rehabilitation units should screen for malnutrition upon admission to rehabilitation and re-screen patients with no initial risk of malnutrition regularly throughout the admission (Marshall et al., 2015, 2016a, 2016b).

- Admission staff should be regularly trained regarding correct implementation of nutrition screening tools and nutrition screening adherence and completion rates should be monitored (Marshall et al., 2015, 2016b).
- All patients identified as at risk of malnutrition, according to any nutrition screening tool, should be immediately referred to the dietitian for a full nutrition assessment (Marshall et al., 2015, 2016a, 2016b).
- Dietitians and rehabilitation staff should not make a malnutrition diagnosis based on evidence provided in a nutrition screening tool (Marshall et al., 2015, 2016a, 2016b).

8.2.1.2 Nutrition assessment and diagnosis

Chapter 2.5.3 summarises convincing evidence that when the BMI is used to diagnose malnutrition, a cut-off of $<23 \text{ kg/m}^2$ should be used in adults ≥ 65 years, due to the significantly increased risk in all-cause mortality. This chapter highlights the limitation in the ICD-10-AM classification of protein-energy malnutrition, used in Australian health care facilities to code for malnutrition, considering it specifies a BMI $<18.5 \text{ kg/m}^2$ regardless of age. Considering that adults aged ≥ 65 years represent the largest aged group of patients admitted to Australian health care institutions (39% of total separations, 70% of sub- and non-acute separations) (2013a), this limitation will have significant impacts on patient outcomes and hospital reimbursements related to case-mix funding. Therefore, a review of the BMI classification used in the ICD-10-AM classification of protein-energy malnutrition is warranted.

The study reported in chapter 5.3.2 has important implications for clinical dietitians in regards to the use of nutrition assessment tools. This was the first study to evaluate the use of the Scored PG-SGA in any older adult population, and it was discovered that the Scored PG-SGA global ratings have strong criterion validity, where they have high accuracy in identifying malnutrition as well being able to predict patient outcomes. The Scored PG-SGA score also had strong criterion validity; however, this study found that a score of ≥ 7 should be used to triage older rehabilitation patients for immediate intervention, as opposed to the score of ≥ 9 which is currently recommended on the tool (appendix IX). This is an important finding; however, more research should confirm the score of ≥ 7 in more diverse older populations before it is applied to all older medical patients. As the current sample investigated the validity of the Scored PG-SGA in older rehabilitation patients only, it is unknown if a score of ≥ 7 or ≥ 9 is more suitable for rehabilitation patients under 65 years, and therefore ≥ 9 should continue to be used until this has been investigated. Also of clinical

relevance, it should be acknowledged that all components of the Scored PG-SGA were completed by the primary researcher, and the patients did not self-complete the initial four boxes of the tool. This was done to follow current standard practice in Australia, but was also a reflection of the sample population which had physical and mental barriers which limited their ability to complete the form, for example admission to rehabilitation post-cardiovascular accident, broken limbs, symptoms of limb weakness and limited vision. This may be relevant in the outcome of the study as the dietitian may score differently to what a patient may self-complete. Practical limitations of the Scored PG-SGA should also be acknowledged, which related to the need for dietitians to undertake training in the implementation and scoring of the Scored PG-SGA and the longer time of implementation compared to the SGA and MNA.

The MNA is the most widely reported nutrition assessment tool in rehabilitation populations; however, its criterion validity had not been sufficiently evaluated. The validity study in chapter 5.3.2 suggested that the cut-off value of <17 recommended on the tool to diagnose malnutrition may not identify all malnourished patients in the geriatric rehabilitation setting. Conversely, using the popular alternative score of <24 (therefore including all patients at risk of malnutrition and malnourished) may overestimate malnutrition, and have significant detrimental impacts upon resource utilisation. Although it may be argued that patients at risk of malnutrition also require nutrition intervention to prevent malnutrition, an accurate diagnosis is still required for hospital coding and funding. The study reported in chapter 5.3.2 found that a score of ≤ 19 had the highest sensitivity and specificity in older rehabilitation patients. Alternatively, patients classified as at risk of malnutrition (MNA score 17 – 23.5) should be monitored regularly or undergo further assessment to determine if they are malnourished.

The narrative review (chapter 5.4.2), which included a review of all nutrition assessment tools evaluated for validity in geriatric rehabilitation, supported the conclusions of the validity study (chapter 5.3.2). Specifically, that the MNA may underdiagnose malnutrition in geriatric rehabilitation, and those classified as “at risk of malnutrition” (MNA score 17 – 23.5) require further assessment and monitoring in order to accurately diagnose malnutrition. The narrative review supports further research to identify a new MNA cut-off value to diagnose malnutrition. It was surprising that the review did not identify any study evaluating the criterion validity of the SGA considering its widespread use by clinical dietitians in all settings. Although the SGA has shown good inter-rater reliability in rehabilitation, and may have strong criterion validity as the ratings align with the Scored

PG-SGA ratings, an independent study evaluating its criterion validity is required before it can be recommended confidently. Furthermore, the narrative review reported that although there is good research to show that a BMI $<23 \text{ kg/m}^2$ can be used to diagnose chronic malnutrition in older adults, all patients at risk of malnutrition should attend a full nutrition assessment as malnutrition can be present even with a healthy or overweight BMI.

The narrative review (chapter 5.4.2) also found that Australia, both rural and metropolitan, has the highest prevalence of malnutrition of any setting and any country. Rehabilitation facilities will therefore need to ensure adequate dietetic staffing, as 30-65% of new admissions will require nutrition assessment by a dietitian, with most of these requiring ongoing nutrition intervention and monitoring.

Finally, the narrative review highlights the similarities and distinctions between malnutrition, sarcopenia, starvation and cachexia. Clinical dietitians are encouraged to consider a diagnosis of sarcopenia and cachexia when assessing the nutrition status of a patient, being aware that nutrition strategies, outcomes and the nutrition care team may need to be modified for each condition. Furthermore, clinical dietitians should be aware that all conditions may exist as comorbidities; however, nutrition support should be provided to at least meet patient requirements in all conditions.

These recommendations for nutrition assessment and diagnosis are summarised as:

- The ICD-10-AM Classification of protein-energy malnutrition should undergo review to consider a higher BMI cut-off to recognise chronic malnutrition in adults aged ≥ 65 years and older (chapters 2.5.2 and 2.5.3).
- All rehabilitation patients identified as at risk of malnutrition by a nutrition screening tool should undergo a full nutrition assessment (Marshall et al., 2016a, 2016b).
- Rehabilitation dietitians should use the Scored PG-SGA when assessing the nutrition status of rehabilitation patients, using the categories of B and C to diagnose malnutrition (Marshall, 2016; Marshall et al., 2016a).
 - A score of ≥ 7 or higher should be used to indicate older rehabilitation patients in critical need of symptom management and nutrition intervention (Marshall et al., 2015b).
 - A score of ≥ 9 or higher should be used to indicate adult rehabilitation patients in critical need of symptom management and nutrition intervention (Ottery, 2000).

- Rehabilitation dietitians who use the MNA to assess the nutrition status of rehabilitation patients should:
 - Use a score of ≤ 19 to diagnose malnutrition until further research is undertaken (Marshall et al., 2016a),
 - Undertake further assessment, such as a detailed physical examination or calculation of dietary requirements and intake, if the patient is considered “at risk of malnutrition” by the MNA (score 17-23.5, (Marshall, 2016; Marshall et al., 2016a), OR
 - Monitor patients at risk of malnutrition regularly if the patient is considered “at risk of malnutrition” by the MNA (score 17-23.5) (Marshall, 2016; Marshall et al., 2016a).
- As no nutrition assessment tools have been evaluated for validity in rehabilitation patients <65 years, rehabilitation patients should use the Scored PG-SGA until further research is undertaken as the MNA is designed only for patients ≥ 65 years (Marshall, 2016).
- Dietitians using the SGA to assess nutrition status in rehabilitation should be aware that it requires further evaluation of its criterion validity before it can be recommended with confidence (Marshall, 2016).
- Rehabilitation dietitians can use a BMI of $<23 \text{ kg/m}^2$ to diagnose chronic malnutrition in adults ≥ 65 years (Marshall, 2016); however, dietitians should be aware that:
 - Patients with a BMI $\geq 23 \text{ kg/m}^2$ may also be malnourished, and require a full nutrition assessment (Marshall, 2016).
 - Due to the ICD-10-AM classification of malnutrition, hospital coding will only consider a patient malnourished with a BMI $<18.5 \text{ kg/m}^2$ in Australia they do not meet the other criteria related to weight loss, dietary intake and physical assessment for recognising acute malnutrition (2008).
- Australian rehabilitation units and dietitians should be aware that approximately 30 – 65% of their new admissions may be malnourished, and should therefore ensure adequate dietetic resources to ensure patients are appropriately screened and assessed for malnutrition (Marshall, 2016).
- Rehabilitation dietitians are encouraged to work with the rehabilitation team to consider if malnutrition exists as a co-morbidity with cachexia or sarcopenia, and

provide nutrition support as an adjunct to the treatments implemented by the multidisciplinary team (Marshall, 2016).

- Rehabilitation dietitians should not use the word “starvation” when diagnosing chronic malnutrition, and should be consistent with the use of “malnutrition” as a diagnostic term. In instances where malnutrition is due to pure chronic starvation, the term starvation-related malnutrition can be used (Marshall, 2016).

8.2.1.3 Nutrition intervention

The systematic review presented in chapter 3.2.2 identified that informal caregivers can play a greater role in nutrition intervention. It found that informal caregivers who receive training via methods such as one-on-one counselling or group education are able to recognise malnutrition and provide treatment to their care-recipients without an increase in their caregiver burden. This finding inspires many opportunities for application in the clinical setting. At the most basic level, it suggests that informal caregivers can form a meaningful and relevant part of the nutrition care team in the community; and community dietitians should aim to ensure their patient’s informal caregiver is present when providing nutrition intervention. Other applications include clinical dietetic departments facilitating group education for informal caregivers of malnourished older adults who are known to the department via outpatient or inpatient referral; or the provision of resource kits for informal caregivers of their malnourished patients. This is particularly the case for informal caregivers of malnourished older adults with dementia, where nutrition education can be combined with other outpatient/community services offered to these caregivers. Strategies such as these are suitable for dietetic services with minimal resources, as it prevents the need for micro-management of nutrition support and will decrease the demand for outpatient or in-home dietetic consultations, overall leading to increased support for a larger number of patients.

Regarding nutrition intervention in rehabilitation, the poor patient outcomes of observational studies (chapters 4.2.2, 5.3.2 and 6.1.2), including the continuing malnutrition throughout the rehabilitation admission and post-discharge in the community, revealed that it is essential that clinical dietitians provide or arrange ongoing nutrition support during the admission and following the discharge. The qualitative study (chapter 7.1.2) recommended such interventions should integrate formal and informal nutrition support in the inpatient rehabilitation setting, so it may continue post-discharge. The qualitative study further suggests that rehabilitation dietitians should take responsibility for engaging the informal caregiver of malnourished older patients, and coordinate nutrition

support strategies which value the informal caregivers' perspective, responsibility and efficacy. By engaging the informal caregivers, nutrition assessment will be more accurate, and nutrition support strategies can be continued by the caregivers frequently during admission and post-discharge. Clinical dietitians should also consider the nutrition ethos of the caregiver, and ensure that all strategies used by the caregivers are evidence-based and appropriate for the patient. Finally, rehabilitation dietitians should place greater consideration upon quality of life, for both the informal caregiver and the patient, during their nutrition intervention.

The inadequate dietetic staffing (as discussed in chapter 5.3.5) of the rehabilitation units in the MARRC study may explain the poor outcomes of the participants. The rehabilitation units were only serviced by a dietitian for six hours per week, which is 12 – 15% of the minimum acceptable standards (2011h). Therefore, dietitians were only able to visit their patients a mean of 1.8 times, which allows for initial nutrition assessment and intervention, but does not allow for sufficient monitoring, evaluation and modification of the intervention plan. It may also prevent engaging with patients' informal caregivers or arranging discharge services. Indeed, the medical records showed that no post-discharge referrals were made to the community dietitian nor were any post-discharge nutrition support options arranged for any patients seen by the rehabilitation dietitian. This finding is likely reflective of many rehabilitation units in Australia, due to the widespread understaffing of dietetics services in rehabilitation (Barrett et al., 2015). The qualitative study, described in chapter 7.1.2, supports the need for adequate dietetic resources, revealing that none of the informal caregivers were engaged by the rehabilitation dietitian despite being wanting to be included in any nutrition support provided to their care-recipients. Furthermore, the narrative review (chapter 5.4.2) revealed that the prevalence of malnutrition in Australian rehabilitation facilities is amongst the highest in the world, where one patient in every two admissions may be malnourished and require the services of a dietitian. Therefore, the validity study (chapter 5.3.2), the narrative review (chapter 5.4.2), and the qualitative study (chapter 7.1.2) reveal that even if improvements are made in the evidence-based practice for clinical dietitians, they are unlikely to be effective until there are adequate staffing levels in rehabilitation.

Regarding discharge nutrition intervention strategies, the acceptability of referrals to the community dietitian will require further investigation as to acceptability. The study in chapter 6.1.2 revealed that nine of the 17 participants who attended the 12 week post-discharge assessment consented to a community dietitian referral; however no participants

had attended an appointment by six months post-discharge although multiple appointment times were offered. There may be several reasons for this, such as disinclination to receive treatment from an unknown health professional, not understanding the purpose of the appointment, or a misunderstanding as to the cost-free nature of the appointment. Engagement of informal caregivers during rehabilitation may help to overcome these limitations, as it is frequently the role of caregivers to assist with attending health care appointments.

These recommendations for nutrition intervention are summarised as:

- Dietitians providing nutrition intervention to community-dwelling malnourished older adults should ensure that the informal caregiver is present during the consultation (with permission from the patient), and are considered an active member of the team when recommending nutrition strategies (Marshall et al., 2013).
- Dietitians should consider providing group education to informal caregivers of malnourished community-dwelling older adults regarding malnutrition intervention and monitoring. For example, as part of post-discharge nutrition support or a community nutrition/health service. This is especially the case for high-risk groups such as caregivers for older adults with dementia. (Marshall et al., 2013).
- Rehabilitation units should ensure they meet minimum recommended dietetic staffing levels, which is based on number of beds (2011h; Marshall et al., 2015, 2016b).
- Rehabilitation dietitians should aim to include the malnourished older rehabilitation patients' informal caregivers as part of the nutrition care team during the admission, which may increase the efficacy and adherence to nutrition interventions, increase the value of nutrition support by the patient and their caregiver, and facilitate transition to post-discharge nutrition support (unpublished data, 2016; chapter 7.1.2).
- Rehabilitation dietitians should be involved in the discharge planning of malnourished patients, ensuring continuing nutrition support and adequate handover to community based dietitians or dietitians consulting RACFs (Marshall et al., 2015, 2016b).
 - Engagement of the patients' informal caregivers is likely to be an important strategy to ensure the patient receives adequate nutrition support once discharged to their own homes, and is able to engage with post-discharge

nutrition services (unpublished work, 2016; chapter 7.1.2)(Marshall et al., 2015).

- Please see chapter 7.1.2 for further detailed suggestions for practice regarding the integration of formal and informal nutrition support services in rehabilitation.

8.2.1.4 Nutrition monitoring and evaluation

The studies reported in chapters 4.2.2, 5.3.2, 5.4.2 and 6.1.2 suggest that patients admitted to rehabilitation with malnutrition require ongoing monitoring and evaluation of their nutrition status throughout the rehabilitation admission and at least 12 weeks post-discharge; however, likely a much longer follow-up of up to 18 months. As reported in chapter 8.2.1.1, patients which are not identified as at risk of malnutrition upon admission to rehabilitation should be re-screened for malnutrition at regular intervals throughout the rehabilitation admission.

The study reported in chapter 6.1.2 uses the Scored PG-SGA to monitor the nutrition status of older rehabilitation patients over the course of their rehabilitation admission and 12 weeks post-discharge to their homes. This study found that the Scored PG-SGA is suitable to monitor a change in nutrition status when repeated at least six days following the previous nutrition assessment; and therefore can be used by clinical dietitians to monitor their nutrition interventions in rehabilitation and in the community. The narrative review reported in chapter 5.4.2 also reports that the MNA score is sensitive to change, and may also be used to monitor change in nutrition status throughout the rehabilitation admission.

These recommendations for nutrition evaluation and monitoring are summarised as:

- All rehabilitation units should continue to monitor for risk of malnutrition through repeated implementation of nutrition screening tools at regular intervals throughout the admission (Marshall et al., 2015, 2016a, 2016b).
- Rehabilitation dietitians should participate in the discharge planning of malnourished older rehabilitation patients, and ensure the patients have ongoing nutrition support and monitoring of nutrition status. For example, nutrition status may be monitored via follow-up telephone calls, post-discharge home visits or outpatient appointments, or referral to community-based nutrition services which report back to the rehabilitation dietitian (Marshall et al., 2014; Marshall et al., 2015).

- The Scored PG-SGA may be used to monitor change in nutrition status throughout the rehabilitation admission and once discharged to the community when repeated at intervals of 6 days or more (Marshall et al., 2015, 2016a).
- The MNA score may be used to monitor change in nutrition status throughout the rehabilitation admission (Marshall, 2016).

8.2.2 Implications for research

The research opportunities regarding malnutrition in the rehabilitation and community settings identified in this thesis are numerous, and addressed here according to the nutrition care process.

8.2.2.1 Implications for research in the rehabilitation setting – nutrition screening

Chapters 5.2 and 5.4 suggest that further research regarding the criterion validity of nutrition screening tools is required. Although the MST was found to have strong concurrent validity, this was in a rural Australian population. The MST should be further evaluated in diverse rehabilitation populations in order to make recommendations more generalisable to all rehabilitation facilities. The MUST, SNAQ, SNAQ⁶⁵⁺, and the NUFFE all require evaluation of their criterion validity when applied to a suitable multidimensional benchmark of malnutrition, and should report all diagnostic statistics such as sensitivity, specificity, kappa statistic, positive predictive value and negative predictive value. For use of the MNA-SF and the SNAQ^{RC} in rehabilitation, research is required which modifies their content or their scoring so that the sensitivity is improved (Marshall, 2016). The Rapid Screen was very close to meeting the *a-priori* values for sensitivity, and therefore perhaps should be further investigated to determine if it does in fact have sufficient concurrent validity. Importantly, all research regarding nutrition screening tools has been undertaken in a research environment, and therefore their validity may not necessarily reflect the true accuracy of the tool in the clinical setting. Further research using a pragmatic approach where non-dietetic staff complete the screening tools would contribute further understanding of the accuracy and usability of these screening tools in rehabilitation.

8.2.2.2 Implications for research in the rehabilitation setting – nutrition assessment and diagnosis

Further evaluation of the validity of the Scored PG-SGA in older non-rehabilitation patients as well as more diverse rehabilitation samples will help to support the conclusion that the Scored PG-SGA is suitable in general older and rehabilitation populations. These studies should evaluate the most suitable Scored PG-SGA score to indicate critical need for intervention, to determine if a score of ≥ 7 is the most appropriate for older medical patients

in general. As the Scored PG-SGA has a substantive subjective component and complex scoring, there is a need to evaluate the inter-rater reliability of this nutrition assessment tool in rehabilitation facilities. There is also a need to evaluate the criterion validity of the SGA in rehabilitation.

The MNA has been examined by three studies in geriatric rehabilitation, and the two of these which were compared to appropriate benchmarks concluded that the standard scoring of the MNA may not be appropriate for geriatric rehabilitation. Therefore, the MNA requires further modification (for example, review of score cut-off values) and re-validation to ensure that it can be used to accurately assess nutritional status in the rehabilitation setting.

The further validation and evaluation of nutrition assessment in rehabilitation will assist in the reporting of malnutrition prevalence. Overall, there are more studies required examining the prevalence of malnutrition in rural populations, in North America, Africa and the UK.

As discussed in chapter 5.4.2, there is emerging research regarding malnutrition-sarcopenia syndrome (MSS) (Vandewoude et al., 2012). Research to design and validate a method of diagnosing MSS will help to target nutrition interventions suitable for patients which present with both malnutrition and sarcopenia as comorbidities. This may help to prevent misdiagnosis of both conditions, and encourage inter-disciplinary action to improve the nutrition status of older patients.

8.2.2.3 Implications for research in the rehabilitation setting – nutrition intervention

Following a validation of a method of diagnosis for MSS, intervention studies targeted at improving the outcomes of patients who present with malnutrition and sarcopenia as comorbidities would be of interest, for example combination of medical nutrition therapy and physical activity.

Regarding examination of current practice, there is a further need for observational research to determine the risk of malnutrition in older adults as they transition from rehabilitation to the community or RACFs in diverse populations, such as metropolitan Australia and international populations. There is also a need for observational studies to examine the nutrition status of malnourished older rehabilitation patients with longer periods of follow-up, for example at six and 12 months post-discharge. This will help to better inform intervention studies and discharge planning for clinical dietitians. Further qualitative studies will also help to strengthen the design of nutrition interventions, for

example examining the roles and experiences and support needs of male informal caregivers of older adults, as well as the older adults themselves.

This thesis has identified a strong need for intervention studies in malnourished rehabilitation patients. Reviews undertaken in chapters 4.2 and 5.4 revealed that nutrition studies in this setting have used various outcomes, making it difficult to compare studies. As such, it is recommended that all nutrition intervention studies in rehabilitation should measure outcomes of clinical relevance post-discharge from rehabilitation, using validated tools where available, such as institutionalisation, hospitalisation, nutrition status, quality of life, physical function and mortality. In particular, all intervention studies should use a nutrition assessment tool which has sufficient validation for the rehabilitation setting; currently this is only the Scored PG-SGA. Qualitative studies of the experiences of patients and informal caregivers alongside intervention studies will help to properly evaluate the impact of the studies, and strengthen recommendations for practice.

Regarding the type of intervention delivered, these should be needs-based, patient-centred and informal caregiver-centred. This thesis has presented a strong case for an intervention study which coordinate efforts of the rehabilitation dietitian, the informal caregiver and the patient to increase the efficacy of nutrition support.

Importantly, the rehabilitation units recruited in the MARRC study did not meet minimum dietetic staffing requirements, highlighting a need for further research evaluating the value of dietitians in rehabilitation. For example, studies examining the cost-effectiveness of dietitians providing treatment for malnutrition in rehabilitation are needed, as well as their impact upon the long-term health care needs of rehabilitation patients. However, as there are already existing dietetics staffing guidelines, rehabilitation units should aim to meet these guidelines prior to the development of further cost-efficacy research.

8.2.2.4 Implications for research in the community setting

Similar to the rehabilitation setting, nutrition screening tools and nutrition assessment tools require further evaluation of criterion validity in the rehabilitation setting. This includes a sufficient review of the criterion validity of tools which have already undergone evaluation, such as the MUST, SNAQ and MNA, as well as evaluation of new tools such as the MST and Scored PG-SGA.

Non-clinical community care workers have shown to be valuable contributors to the nutrition care team through the implementation of nutrition screening programs; however, their role in managing malnutrition in community dwelling older adults is largely

unexplored and interventions studies which evaluate their clinical and economic efficacy would be valuable in this area. However, without the direct input of health professionals, methods of quality control will need to be determined, as will the acceptability of the scheme by community care organisations.

Regarding the role informal caregivers as part of the nutrition care team, in both monitoring nutritional risk and delivering nutrition intervention, there is a general need for well-designed and adequately powered trials before strong recommendations can be made for practice. Specifically, further evidence is needed to address caregiver's roles in affecting malnutrition risk in the general older adult population as opposed to certain high risk groups, such as dementia, only.

8.2.3 Implications for policy

8.2.3.1 Implications for policy in rehabilitation

The research findings described in chapter 4, 5 and 6, particularly the high malnutrition prevalence and poor post-discharge outcomes, strongly suggest that nutrition policies in rehabilitation facilities need to include adequate dietetic staffing and need to include nutrition support as a key component of the rehabilitation care plan, including discharge planning. Implementation of these two policies alone should significantly improve the long term health and nutrition status of malnourished patients in rehabilitation, and indeed, all evidence suggests this should be basic standard care.

Regarding the implementation of the nutrition care process in rehabilitation facilities, the evidence suggests nutrition screening should be completed on admission to rehabilitation and at regular intervals during the admission via the MST, with a score of 2 or higher triggering a referral to the dietitian. Nutrition assessment should be completed following all referrals via the nutrition screening pathway, and the evidence suggests this should be completed via the Scored PG-SGA. There is insufficient evidence to recommend a specific method of nutrition intervention; however, nutrition intervention should at least meet the minimum energy and protein requirements via a method which is suitable and acceptable to the patient. However, evidence does suggest that including the informal caregiver in the nutrition intervention may improve patient outcomes in the long term. Nutrition policy should specify that the dietitian is involved in inpatient care and multidisciplinary discharge support. Specifically, if the patient remains malnourished at discharge and the patient is to receive transitional care, such as in-home or outpatient ambulatory rehabilitation, that this should always involve the dietitian to continue nutrition support. Furthermore,

malnourished patients at discharge should be engaged with community-based nutrition support, and if they are being discharged to an RACF, ensure adequate handover to the consulting dietitian.

8.2.3.2 Implications for policy in the community setting

Community care organisations have a unique and unparalleled access to community-dwelling older adults, usually those with acknowledged physical limitations which may increase their risk of malnutrition. Broadening the scope of practice by community organisations to include nutrition screening may be one of the most important and influential strategies to help older Australians to remain in their own homes. Nutrition screening training and implementation may require significant resources to be initiated within the organisation; however, would increase the value and efficacy of the organisation not only to their care-recipients but also to the health and aged care systems, and therefore the government. Research presented in chapter 1, 2 and 3 recommends that community care organisations implement a nutrition care policy and engage with a private or community dietitian. The nutrition care policy should include a clear and simple nutrition screening pathway with efficient referral systems in place to decrease caregiver burden. Currently, there is no evidence for nutrition intervention or monitoring by community care workers, but they may have a role in the future.

Regarding the nutrition policy of community nutrition organisations, such as community nutritionists and community dietitians, there is good evidence to recommend the implementation of group or one-on-one education and training of informal caregivers of malnourished older adults. The systematic review conducted in chapter 3.2.2 suggests informal caregivers can undertake tasks such as maintaining weight records and nutrition screening as well as nutrition intervention such as providing a HPHE diet, and obtaining and encouraging ONS in an individualised manner to suit the preferences and needs of their care-recipient. This is particularly the case for caregivers of malnourished older adults with dementia, but is likely to be beneficial for the general older adult community.

8.3 Malnutrition on the rehabilitation agenda

Malnutrition is on the dietitian's agenda. It is one of the conditions for which dietitians are specifically trained and regularly practice, especially in the acute and rehabilitation settings. However, it is only one condition among many for the policy makers and managers to consider in their planning of how health care facilities are managed and funded; and it appears that it is not a priority for rehabilitation facilities. This is the case despite strong evidence showing its high cost and patient burden, but very cost-effective treatment. This under-recognition persists despite good evidence showing Australia has the highest prevalence of malnutrition in rehabilitation in the world. Therefore, the understaffing of dietitians in rehabilitation and the continued under-recognition of malnutrition is a missed opportunity and a failure of nutrition care to the public. This is not acceptable. The under-recognition of malnutrition in our respected older population is both unethical and illogical.

But how will this change? Who will advocate for malnutrition to be addressed in rehabilitation? As dietitians have the unique training and specialisation to manage malnutrition clinically, it can be argued this advocacy role lies within the dietetics profession. Whilst individual dietitians can advocate for better nutritional care within their facility, a broad approach needs to be taken by the dietetics profession as a whole. It is the role of the DAA to provide strategic leadership for dietitians in Australia. The front page of their website reads *"The Dietitians Association of Australia (DAA) is the peak body of dietetic and nutrition professionals, providing strategic leadership in food and nutrition through empowerment, advocacy, education, accreditation and communication"* (2013c).

In their role of advocacy and empowerment, the DAA have been working in the area of increased recognition of malnutrition and the role of dietitians as part of the allied health care team. As informed through personal communication with the DAA senior policy advisor Annette Byron (27 May 2016), the DAA have taken action in the area of malnutrition in RAC through advocating to the Australian Aged Care Quality Agency and by joining the National Aged Care Alliance. In the community setting, DAA have participated in several ventures related to home delivered meals, and advocacy for equal access to health services for rural and remotely dwelling people with chronic disease. Lastly and importantly, DAA have commissioned a document to provide evidence for including malnutrition in the accreditation standards mandated for Australian hospitals. This document was provided to the Australian Commission for Safety and Quality in Health Care in January in 2015, and nutrition was included in an unknown capacity on draft

2 of the revised National Safety and Quality Health Service (NSQHS) which is no longer available for comment. While the inclusion of malnutrition in the NSQHS may be relevant to rehabilitation units, the DAA has not yet undertaken any targeted advocacy or action to address malnutrition in rehabilitation (personal communication with Annette Byron, 27 May 2016).

In order to improve the outcomes of malnourished older adults across the continuum of care, DAA must continue to advocate for the role of dietitians in managing malnutrition across the continuum of care, with further advocacy required in the rehabilitation and rural communities. In order to have a significant effect, this advocacy must be broad and comprehensive, such as letters to elected officials, raising public awareness, participation on health service boards, preparation of reports and guidelines, greater links with other geriatric and allied health professions and, most importantly, working to secure the appropriate participation of dietitians as part of the health care team. Other strategies may include working with universities and providing CPD opportunities for dietitians in health care management, advocacy skills, and how to influence and contribute to health care policy.

In addition, the majority of research concerning malnutrition in rehabilitation has been undertaken in Australia, and therefore advocacy for malnutrition management in rehabilitation is required not only in Australia but internationally. Therefore, Australia can continue play an important role in setting the benchmark for managing malnutrition in rehabilitation and raising the profile of dietitians as part of the multidisciplinary rehabilitation team. For example, this may be accomplished through further active participation and advocacy at international dietetic and multidisciplinary conferences and other international health care groups such as the International Confederation of Dietetic Associations (ICDA), PEN and the WHO.

This thesis concludes with a call to action. In order for dietitians to have relevance in the Australian health and aged care settings, nutrition care needs to align with the active ageing policies implemented by the Australian government. Therefore, we call on the dietitians of Australia and the DAA to advocate for malnutrition to be of higher consideration on the rehabilitation agenda, and for the increased inclusion and protection of dietitians in Australian health and aged care institutions. Only by this broad and coordinated approach will outcomes be improved for all older rehabilitation patients.



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APPENDICES

Appendix I

Table 1 from the National Health and Medical Research Council (NHMRC) additional levels of evidence and grades for recommendations for developers of guidelines: NHMRC levels of evidence according to type of research question (Coleman et al., 2005)

Table 1. Designations of levels of evidence* according to type of research question (including tablenotes)

Level	Intervention §	Diagnosis **	Prognosis	Aetiology †††	Screening
I *	A systematic review of level II studies	A systematic review of level II studies	A systematic review of level II studies	A systematic review of level II studies	A systematic review of level II studies
II	A randomised controlled trial	A study of test accuracy with: an independent, blinded comparison with a valid reference standard, §§ among consecutive patients with a defined clinical presentation ††	A prospective cohort study ***	A prospective cohort study	A randomised controlled trial
III-1	A pseudorandomised controlled trial (i.e. alternate allocation or some other method)	A study of test accuracy with: an independent, blinded comparison with a valid reference standard, §§ among non-consecutive patients with a defined clinical presentation ††	All or none §§§	All or none §§§	A pseudorandomised controlled trial (i.e. alternate allocation or some other method)
III-2	A comparative study with concurrent controls: <ul style="list-style-type: none"> • Non-randomised, experimental trial † • Cohort study • Case-control study • Interrupted time series with a control group 	A comparison with reference standard that does not meet the criteria required for Level II and III-1 evidence	Analysis of prognostic factors amongst untreated control patients in a randomised controlled trial	A retrospective cohort study	A comparative study with concurrent controls: <ul style="list-style-type: none"> • Non-randomised, experimental trial • Cohort study • Case-control study
III-3	A comparative study without concurrent controls: <ul style="list-style-type: none"> • Historical control study • Two or more single arm study ‡ • Interrupted time series without a parallel control group 	Diagnostic case-control study ††	A retrospective cohort study	A case-control study	A comparative study without concurrent controls: <ul style="list-style-type: none"> • Historical control study • Two or more single arm study
IV	Case series with either post-test or pre-test/post-test outcomes	Study of diagnostic yield (no reference standard) ††	Case series, or cohort study of patients at different stages of disease	A cross-sectional study	Case series

Tablenotes

* A systematic review will only be assigned a level of evidence as high as the studies it contains, excepting where those studies are of level II evidence.

§ Definitions of these study designs are provided on pages 7-8 *How to use the evidence: assessment and application of scientific evidence* (NHMRC 2000b).

† This also includes controlled before-and-after (pre-test/post-test) studies, as well as indirect comparisons (ie. utilise A vs B and B vs C, to determine A vs C).

‡ Comparing single arm studies ie. case series from two studies.

** The dimensions of evidence apply only to studies of diagnostic accuracy. To assess the effectiveness of a diagnostic test there also needs to be a consideration of the impact of the test on patient management and health outcomes. See *MSAC (2004) Guidelines for the assessment of diagnostic technologies*. Available at: www.msac.gov.au.

§§ The validity of the reference standard should be determined in the context of the disease under review. Criteria for determining the validity of the reference standard should be pre-specified. This can include the choice of the reference standard(s) and its timing in relation to the index test. The validity of the reference standard can be determined through quality appraisal of the study. See Whiting P, Rutjes AWS, Reitsma JB, Bossuyt PMM, Kleijnen J. The development of QUADAS: a tool for the quality assessment of studies of diagnostic accuracy included in systematic reviews. *BMC Medical Research Methodology* 2003, 3: 25.

†† Well-designed population based case-control studies (eg. population based screening studies where test accuracy is assessed on all cases, with a random sample of controls) do capture a population with a representative spectrum of disease and thus fulfil the requirements for a valid assembly of patients. However, in some cases the population assembled is not representative of the use of the test in practice. In diagnostic case-control studies a selected sample of patients already known to have the disease are compared with a separate group of normal/healthy people known to be free of the disease. In this situation patients with borderline or mild expressions of the disease, and conditions mimicking the disease are excluded, which can lead to exaggeration of both sensitivity and specificity. This is called spectrum bias because the spectrum of study participants will not be representative of patients seen in practice.

‡‡ Studies of diagnostic yield provide the yield of diagnosed patients, as determined by an index test, without confirmation of the accuracy of this diagnosis by a reference standard. These may be the only alternative when there is no reliable reference standard.

*** At study inception the cohort is either non-diseased or all at the same stage of the disease.

§§§ All or none of the people with the risk factor(s) experience the outcome. For example, no smallpox develops in the absence of the specific virus; and clear proof of the causal link has come from the disappearance of small pox after large-scale vaccination.

††† If it is possible and/or ethical to determine a causal relationship using experimental evidence, then the 'Intervention' hierarchy of evidence should be utilised. If it is only possible and/or ethical to determine a causal relationship using observational evidence (ie. cannot allocate groups to a potential harmful exposure, such as nuclear radiation), then the 'Aetiology' hierarchy of evidence should be utilised.

Note 1: Assessment of comparative harms/safety should occur according to the hierarchy presented for each of the research questions, with the proviso that this assessment occurs within the context of the topic being assessed. Some harms are rare and cannot feasibly be captured within randomised controlled trials; physical harms and psychological harms may need to be addressed by different study designs; harms from diagnostic testing include the likelihood of false positive and false negative results; harms from screening include the likelihood of false alarm and false reassurance results.

Note 2: When a level of evidence is attributed in the text of a document, it should also be framed according to its corresponding research question eg. level II intervention evidence; level IV diagnostic evidence; level III-2 prognostic evidence.

Hierarchies adapted and modified from: NHMRC 1999; Blandier 1999; Lijmer et al. 1999; Phillips et al. 2001.

Appendix II

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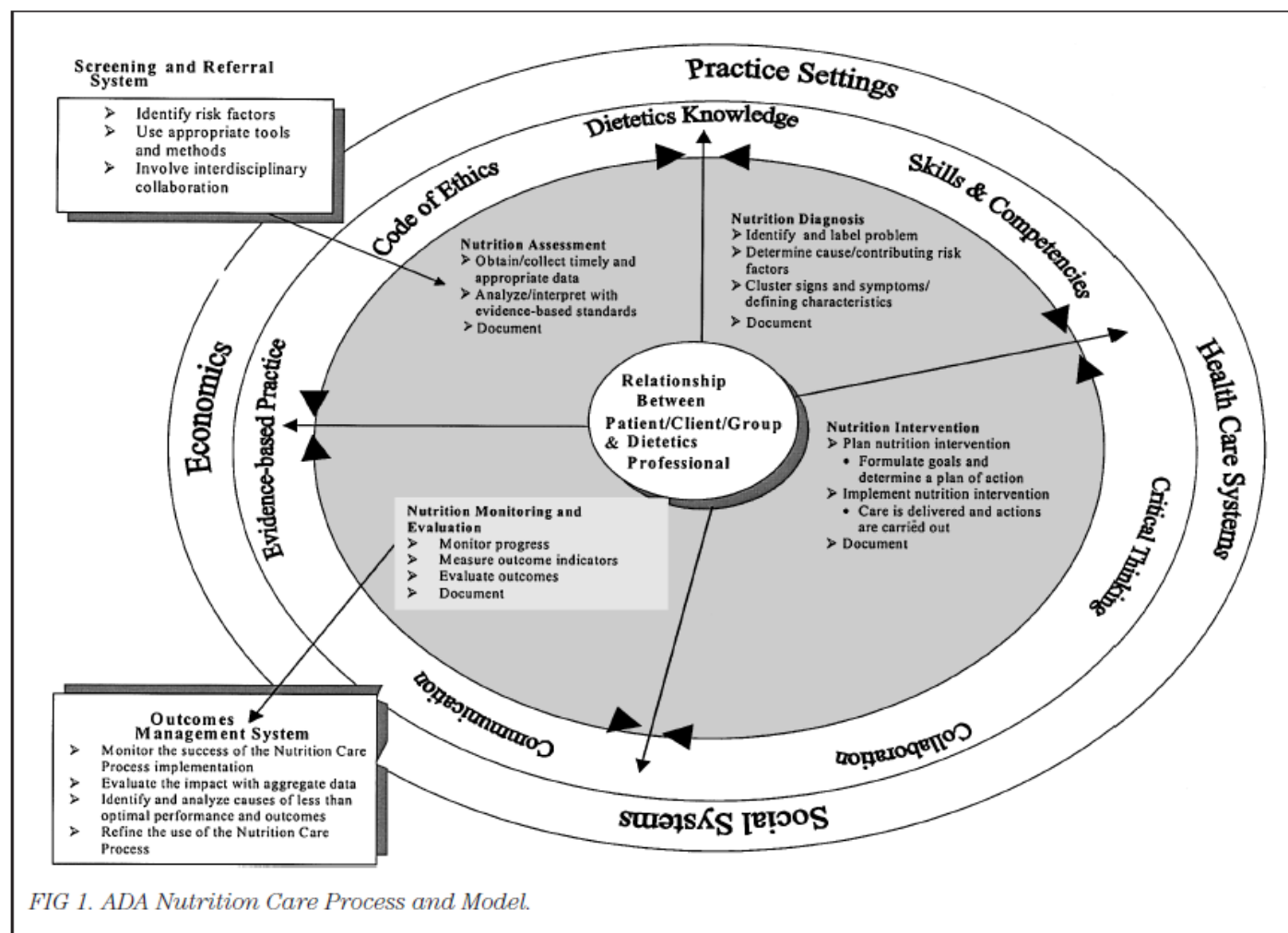
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Appendix III

Figure 1 of the Academy of Nutrition and Dietetics (formerly American Dietetics Association) Nutrition Care Process and Model from the Nutrition Care Process and Model: ADA adopts road map to quality care and outcomes management (Lacey & Prichett, 2003). Included with permission by Elsevier (permissions appendix XI).



Appendix IV

Table 1 from the Consensus statement: Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition: Characteristics Recommended for the Identification and Documentation of Adult Malnutrition (Undernutrition)(White et al., 2012). Included with permission by Elsevier (permissions appendix II).

Table 1. Academy/A.S.P.E.N. Clinical Characteristics That the Clinician Can Obtain and Document to Support a Diagnosis of Malnutrition

Clinical Characteristic	Malnutrition in the Context of Acute Illness or Injury				Malnutrition in the Context of Chronic Illness				Malnutrition in the Context of Social or Environmental Circumstances			
	Nonsevere (Moderate) Malnutrition		Severe Malnutrition		Nonsevere (Moderate) Malnutrition		Severe Malnutrition		Nonsevere (Moderate) Malnutrition		Severe Malnutrition	
(1) Energy intake¹ Malnutrition is the result of inadequate food and nutrient intake or assimilation; thus, recent intake compared with estimated requirements is a primary criterion defining malnutrition. The clinician may obtain or review the food and nutrition history, estimate optimum energy needs, compare them with estimates of energy consumed, and report inadequate intake as a percentage of estimated energy requirements over time.	<75% of estimated energy requirement for >7 days		≤50% of estimated energy requirement for ≥5 days		<75% of estimated energy requirement for ≥1 month		≤75% of estimated energy requirement for ≥1 month		<75% of estimated energy requirement for ≥3 months		≤50% of estimated energy requirement for ≥1 month	
(2) Interpretation of weight loss²⁻⁵ The clinician may evaluate weight in light of other clinical findings, including the presence of under- or overhydration. The clinician may assess weight change over time reported as a percentage of weight lost from baseline.	% 1–2 5 7.5	Time 1 wk 1 mo 3 mo	% >2 >5 >7.5	Time 1 wk 1 mo 3 mo	% 5 7.5 10 20	Time 1 mo 3 mo 6 mo 1 y	% >5 >7.5 >10 >20	Time 1 mo 3 mo 6 mo 1 y	% 5 7.5 10 20	Time 1 mo 3 mo 6 mo 1 y	% >5 >7.5 >10 >20	Time 1 mo 3 mo 6 mo 1 y
Physical Findings^{5,6} Malnutrition typically results in changes to the physical exam. The clinician may perform a physical exam and document any one of the physical exam findings below as an indicator of malnutrition.												
(3) Body fat Loss of subcutaneous fat (eg, orbital, triceps, fat overlying the ribs)	Mild		Moderate		Mild		Severe		Mild		Severe	
(4) Muscle mass Muscle loss (eg, wasting of the temples [temporalis muscle], clavicles [pectoralis and deltoids], shoulders [deltoids], interosseous muscles, scapula [latissimus dorsi, trapezius, deltoids], thigh [quadriceps], and calf [gastrocnemius])	Mild		Moderate		Mild		Severe		Mild		Severe	
(5) Fluid accumulation The clinician may evaluate generalized or localized fluid accumulation evident on exam (extremities, vulvar/scrotal edema, or ascites). Weight loss is often masked by generalized fluid retention (edema), and weight gain may be observed.	Mild		Moderate to severe		Mild		Severe		Mild		Severe	

Table 1. (continued)

Clinical Characteristic	Malnutrition in the Context of Acute Illness or Injury		Malnutrition in the Context of Chronic Illness		Malnutrition in the Context of Social or Environmental Circumstances	
	Nonsevere (Moderate) Malnutrition	Severe Malnutrition	Nonsevere (Moderate) Malnutrition	Severe Malnutrition	Nonsevere (Moderate) Malnutrition	Severe Malnutrition
(6) Reduced grip strength ⁷ Consult normative standards supplied by the manufacturer of the measurement device	NA	Measurably reduced	NA	Measurably reduced	NA	Measurably reduced

A minimum of 2 of the 6 characteristics above is recommended for diagnosis of either severe or nonsevere malnutrition. NA, not applicable.

Notes:

Height and weight should be measured rather than estimated to determine body mass index (BMI).

Usual weight should be obtained to determine the percentage and to interpret the significance of weight loss.

Basic indicators of nutrition status such as body weight, weight change, and appetite may substantively improve with refeeding in the absence of inflammation. Refeeding and/or nutrition support may stabilize but not significantly improve nutrition parameters in the presence of inflammation.

The National Center for Health Statistics defines *chronic* as a disease/condition lasting 3 months or longer.⁸

Serum proteins such as serum albumin and prealbumin are not included as defining characteristics of malnutrition because recent evidence analysis shows that serum levels of these proteins do not change in response to changes in nutrient intake.⁹⁻¹²

Table 1. References

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Appendix V

Agarwal E, Marshall S, Miller M, Isenring E. Optimising nutrition in residential aged care: a narrative review. *Maturitas*. 2016; In Press.
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Title: Optimising nutrition in residential aged care: a narrative review

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Abstract

In developed countries the prevalence of protein-energy malnutrition increases with age and multi-morbidities increasing nutritional risk in aged care residents in particular. The purpose of this paper was to examine, synthesise and develop a narrative review of the current literature on the identification, prevalence, associated risk factors, consequences, and management of malnutrition in the residential aged care (RAC) setting. We performed searches of English language publications in Medline, PubMed, Ovid and the Cochrane Library from January 1 1990- November 25 2015. We found that, on average, half of all residents in aged care are malnourished as a result of factors affecting appetite, dietary intake and nutrient absorption. Malnutrition is associated with a multitude of adverse outcomes including increased risk of infections, falls, pressure ulcers and hospital admissions, all of which can lead to increased health care costs and poorer quality of life. A number of food and nutrition strategies have demonstrated positive nutritional and clinical outcomes in the RAC setting. These strategies extend beyond simply enhancing the nutritional value of foods and hence necessitate the involvement of a range of committed stakeholders. Implementing a nutritional protocol in RAC facilities that comprises of routine nutrition screening, assessment, appropriate nutrition intervention, including attention to food service systems, and monitoring by a multidisciplinary team can help prevent decline in residents' nutritional status. Food and nutritional issues should be identified early and managed on admission and regularly in the RAC setting.

Keywords: Malnutrition, Aged, Nutrition Assessment, Nutritional Support

1. Introduction

The proportion of the world's population aged 60 years and over is rapidly increasing (1). Whilst this population has doubled from 12% in 1950 to 23% in 2013, it is projected to triple to 32% by 2050 (1, 2). In developed countries improvements in healthcare have led to declines in mortality from conditions such as stroke and heart disease (3). However, increased longevity has resulted in an increased prevalence of chronic illness and multi-morbidities (defined as the presence of two or more diseases at the same time); along with a burgeoning demand for residential aged care (RAC) services to offer accommodation and support for older people with complex needs who can no longer live independently in their home (4, 5).

Malnutrition (or inadequate nutritional status) in older people is defined as undernourishment due to poor dietary intake consequently leading to involuntary weight loss and muscle wasting (6). Although frail older persons are at an increased risk of malnutrition, research indicates that nutrition often ranks low on the list of care priorities in RAC (7). Lack of knowledge and awareness, and the inability to identify malnutrition by care staff; rushed and task-focussed eating environments that are often accompanied by little communication and conversation between residents and staff assisting with feeding; and residents' own physical, clinical, and psychosocial issues have been identified as major barriers against the prevention and management of malnutrition in the elderly (7-12). In a recent poll conducted by the International Association of Gerontology and Geriatrics, RAC experts from eight countries identified "improving nutrition" as one of the top five international research priorities in this setting (13). To the best of our knowledge, previously published reviews in the RAC setting have summarised evidence regarding malnutrition prevalence (14), associated risk factors (15), and effective nutritional interventions (16-18). The purpose of this paper is to review and summarise existing evidence on these aspects of malnutrition in the RAC setting, along with including a synopsis of evidence-based methods to identify malnutrition in the RAC setting, highlight the consequences of malnutrition in this population and provide future directions for practice and research.

2. Methods

In the literature, depending on the geographical location, low care settings may also be referred to as "hostels", "residential care homes", or "assisted care"; whereas high care settings may also be referred to as "nursing homes". For the purpose of this paper, the

term RAC will encompass both low and high care settings. References for this narrative review were identified through searches of publications listed in electronic databases including Medline, PubMed, Ovid, and the Cochrane Library. The searches were limited to full-length articles, in the English language, and publications dated from 1 January 1990 to 25 November 2015. The titles and abstracts of articles were examined using the following keywords: “nursing homes”, “residential aged care facility”, “elderly”, “older adults”, “malnutrition”, “nutritional status”, “multicentre”, “prevalence”, “aetiology”, “consequences”, “health-related outcomes”, “nutritional interventions”, “dietary intake”, and “enteral nutrition”. Retrospective searches were also conducted from relevant review articles, book chapters and relevant evidence-based guidelines. Further details of the search methods are available from the corresponding author.

3. Identification of malnutrition in RAC

Although there is no gold standard for diagnosing malnutrition, it is generally accepted that the condition is characterised by unintentional weight loss with suboptimal dietary intake, thereby resulting in muscle wasting and/or loss of subcutaneous fat; or low BMI ($\leq 18.5 \text{ kg/m}^2$) (19). However, in a recent meta-analysis evaluating the association of BMI and all-cause mortality in older adults, Winter and colleagues observed that when compared with a BMI reference range of 23.0-23.9 kg/m^2 , a BMI of 21.0-21.9 kg/m^2 and a BMI of $\leq 20.0 \text{ kg/m}^2$ demonstrated a 12% and 28% greater risk of all-cause mortality respectively (20). This meta-analysis indicates that the healthy BMI range for adults (18.5-24.9 kg/m^2) as established by the World Health Organisation is not suitable for older adults and that individuals with a BMI of $<23.0 \text{ kg/m}^2$ should be monitored for changes in weight and risk of malnutrition (20). Research also indicates that a moderately higher BMI is protective against morbidity and mortality (21, 22).

It is important to remain mindful that just like some laboratory parameters (albumin, transferrin, and lymphocyte count) are more indicative of illness rather than nutritional deficits, body weight is also affected by health status rather than nutrition exclusively (23). Therefore, rather than relying on a single parameter to identify malnutrition, it is believed that nutrition screening and assessment tools are more suitable to identify malnutrition risk and malnutrition as they take into account its complex multifactorial aetiology including biological, iatrogenic, socioeconomic, psychological and physical risk factors (24). Of the several nutrition screening tools available in the literature, many have been developed for older adults (25-31) and some have been specifically developed

for use in the RAC setting (32-35). However, recent systematic reviews concluded that few tools have undergone rigorous reliability and validity testing; the ability of nutrition screening tools to screen nutritional status and predict outcomes in RAC residents ranges from fair-to-moderate; and that more items that are specific to development of malnutrition in this population (dietary factors, feeding dependence, oral health, environment, comorbidities) need to be included in the tools (24, 36, 37).

White et al have proposed that since no single parameter can define malnutrition, the diagnosis of malnutrition should be made with the identification of two or more of the following characteristics rather than depend on any particular nutrition screening tool (38):

- Inadequate energy intake: defined as consuming $\leq 75\%$ of estimated energy requirements for at least one month;
- Weight loss: defined as unintended loss of at least 5% usual body weight within one month and/or at least 10% loss in usual body weight within six months;
- Loss of muscle mass: defined as mild-to-severe visible wasting of the temples, clavicles, shoulders, interosseous muscles, scapula, thigh and calf;
- Loss of subcutaneous fat: defined as mild-to-severe visible wasting orbital, triceps, and fat overlying the ribs;
- Localised or generalised fluid accumulation: in the extremities, vulvar/scrotal oedema, and ascites;
- Reduced functional capacity: determined by handgrip strength.

However, this proposed consensus definition for malnutrition is still to be tested for validity and is a work in progress. Comprehensive assessment of nutritional status by trained professionals, such as dietitians, is essential once malnutrition risk has been identified. Nutrition assessment uses a combination of medical history, nutritional data, physical examination, anthropometric measurements, and biochemical parameters to determine the individual's nutritional status (38). The Subjective Global Assessment (SGA) (39), scored Patient-Generated Subjective Global Assessment (PG-SGA) (40), and Mini-Nutritional Assessment (41) are multidimensional nutrition assessment tools validated for the RAC setting (42-45) and include a range of parameters to make a nutritional diagnosis and initiate nutritional management in older residents.

4. Prevalence of malnutrition in RAC

Bell et al recently published a systematic review on malnutrition prevalence in the RAC setting (14). The review included studies that were published from 1999-2011, single and multicentre studies, and cohorts ranging from 50–11,902 RAC residents (14). Various methods such as nutrition screening and assessment tools, body mass index (BMI), weight loss percentage, anthropometric measurements, and weight were utilised to determine malnutrition prevalence (14). Malnutrition risk and prevalence were estimated to range from 29-97% and 4-71% respectively, with the large variation attributed to selection bias and research methodology to define malnutrition (14). However, in most studies malnutrition risk and prevalence were reportedly between 47-62% and 20-39% respectively (14). The findings of this review are consistent with results from other multicentre studies since published from regions including Iran, Italy, Austria and Finland (46-50).

5. Aetiology of malnutrition in RAC

The aetiology of malnutrition in older adults is complex and multifactorial. Inadequate dietary intake is the leading cause of malnutrition in older adults (51). A physiological reduction in appetite and energy intake, referred to as the “anorexia of ageing”, occurs naturally with progressive aging and usually exceeds the reduction in energy expenditure, resulting in unintentional weight loss mainly in the form of lean body mass (52). Additionally, a multitude of factors often referred to as the “nine D’s” (Figure 1) are commonly observed in older adults and are associated with difficulty with self-feeding; social and financial problems; impaired digestion, absorption, and excretion of nutrients; and gastrointestinal symptoms (such as nausea, constipation, vomiting, diarrhoea, loss of appetite, and early satiety); resulting in decreased food consumption and exacerbation of malnutrition (12, 15, 53-61). The use of plastic dishware has been associated with malnutrition due to its potential influence on taste of food items and residents’ perception of being in hospital (62). Although not well explored in the literature, food insecurity (or the limited ability or uncertainty in accessing adequate, safe, and nutritious food that meets one’s taste and cultural preferences in a socially acceptable manner) has also been implicated in the aetiology of malnutrition in the RAC setting (63, 64). RAC residents are particularly vulnerable to food insecurity due to their increasing age, presence of debilitating diseases, lack of control over food intake and preferences, declining physical and psychological health, and limited social and financial capacity (62, 64). Evidence also

indicates that the inability of nursing staff to identify and recognise malnutrition as a formidable problem in the RAC setting results in them not prioritising nutrition care for the residents thereby adding to risk of RAC residents developing malnutrition (7, 10, 65).

6. Consequences of malnutrition in RAC

Malnutrition bears significant and diverse consequences including physiological, psychosocial and healthcare costs-related consequences.

6.1. Physiological consequences: The breakdown of liver protein during catabolism in malnourished older adults inhibits hepatic protein synthesis leading to a decrease in immune cells and serum proteins (66). This can cause anaemia, oedema, poor wound healing and impaired immunity with the consequence of increased susceptibility to infections and pressure ulcers. The loss of cardiac muscle decreases cardiac output thereby compromising heart function (67). The ability to control breathing becomes impaired due to the loss of respiratory muscle mass and strength as well as decreased production of surfactant (68). Malnutrition further affects lung structure, elasticity and immune defence and pulmonary oedema can result due to a decrease in colloidal osmolarity secondary to hypoproteinaemia (68). The combination of sarcopenia, loss of fat, impaired cardiac and respiratory function and impaired thermoregulation contribute to a significantly increased risk of falls (69). Malnutrition-related decreasing physical function in multiple organ systems is also associated with an increased risk of mortality (70). Malnutrition was found to be independently associated with a 3- to 6-fold increased risk of mortality in RAC (71-73). Furthermore, significant weight loss within six months and/or eating problems in RAC residents has also been found to increase the risk of 3 month mortality by 20% (74).

6.2. Psychosocial consequences: Depression is prevalent in older adults, with rates of up to 45% in the institutionalised elderly (75, 76). Depression is associated with weight loss and although the association between depression and nutritional status is multifactorial it is unclear if it is a cause and/or consequence of malnutrition in older residents (77-81). As a result of these physiological and psychosocial outcomes, malnutrition in the individual leads to decreased physical functioning and quality of life (82).

6.3. Healthcare costs-related consequences: Beyond the burden of malnutrition to the resident, malnutrition also contributes significantly towards the economic burden in RAC facilities. While the additional cost of malnutrition in the RAC setting has been estimated

in excess of €450 million (USD\$489 million) (83), the cost of treating malnourished patients in RAC in the UK has been estimated at £2.6 billion (USD\$3.9 billion) (84).

Based on the foregoing it can be inferred that early identification and management of malnutrition is imperative not only to manage the associated physiological and psychosocial consequences for residents but also to minimise associated health-related costs.

7. Nutritional management of malnutrition in RAC

Malnutrition is preventable and treatable, and in some instances completely reversible. The goals of managing the nutritional status of long term RAC residents include not only the treatment of malnutrition but also the prevention of decline in nutritional status (85, 86). Although mealtimes are recognized as ‘the highlight of the day’ for many RAC residents (87) admission to RAC is known to come with challenges for residents including adjusting to specific meal times and choices, and dining companions and environments; and depending on RAC menus solely for their nutritional intake (88). It has been suggested that malnutrition may be caused iatrogenically by dietary accreditation standards that are either inadequate at meeting nutritional requirements of elderly residents (89) or extremely limited in offered choices related to menu selection (90, 91). Therefore, to alleviate the issue of malnutrition in the RAC setting, there is increasing recognition for (a) revising existing menu guidelines to address nutritional requirements of elderly residents likely to have limited food intake (89); (b) accommodating residents’ preferences based on cultural diversity and special dietary requirements (92); (c) improving mealtime choices and variety offered to residents (88). Furthermore, staff education, regular monitoring for nutritional risk and weight, with prompt and individualised triage for malnourished residents is crucial in the management of malnutrition (93-95). In addition, the training and appointment of a staff member as a nutrition coordinator or champion has also demonstrated positive results in managing malnutrition in RAC (96). Evidence highlighting the use of various strategies to improve residents’ nutritional status is as below:

7.1 Evidence for the use of modifications to food and mealtimes in the RAC setting:

Since inadequate food intake is the most prominent risk factor contributing to malnutrition in the elderly it is logical to implement strategies that improve food intake in the treatment of malnutrition.

(i) *Meal enrichment*: The provision of energy- and protein-enriched meals and snacks is a low-cost, ‘food first’ approach to improving nutrient intake without increasing the amount of food offered, and may prevent decline in nutritional and functional status for at risk populations (97-99). Therefore, the provision of a high energy-high protein diet, such as through the addition of milk powder, egg yolk, nuts, oil and cream, as well as dairy-based mid-meals, should be provided to older RAC residents who are found to be at risk of malnutrition (98, 100-103). However, research also suggests that food fortification is unlikely to provide sufficient nutritional support to treat residents with overt malnutrition or significantly improve physical function (100-102, 104). This may be due to the poor intervention adherence of residents and staff, short intervention periods, insufficient nutrition support, and insufficient physical activity in a largely frail and immobile population (100-102, 105, 106).

(ii) *Therapeutic diets*: An Australian study comprising of 199 residents from 18 RAC facilities found that whilst residents’ nutritional intake was inadequate in meeting their energy and protein requirements, their sodium intake was three times higher than the recommendation (106). Sugar intake was also high and mainly contributed by excessive serves of ‘extras’ (including cakes, biscuits, confectionery, soft drinks, and ice-cream) (106). Research demonstrates that prescriptive therapeutic diets, often used in aged care for conditions such as diabetes and cardiovascular diseases, may increase the risk of malnutrition due to their restrictive nature (12, 107). To prevent excessive intake of sodium, the use of herbs and spices as flavour enhancers is recommended to improve flavour perception that may be affected by age-related sensory deficits. Regular physical activity is also a beneficial alternative to food restriction due to its multifactorial effect including increased insulin sensitivity, improved cardiovascular profile, improved muscle mass, and enhanced quality of life.

(iii) *Texture modified diets*: It is estimated that over half the RAC population is affected by degenerative conditions such as dementia, stroke, Parkinson’s disease and Alzheimer’s disease that commonly results in dysphagia, or a dysfunctional swallow (108). Texture modified diets are therefore often prescribed to residents with dysphagia and/or poor dentition (108, 109). However, texture modified diets are known to be nutritionally dilute due to the addition of fluid to achieve desired consistency, are limited in choice, and visually unappetizing thereby contributing towards reduced intake and thus malnutrition (88, 109-111). To manage these issues, Germain et al used a technology that reformed the appearance of smoot homogenous pureed food to look like its natural form, without

altering the nutritional content of the food (108). When malnourished residents with dysphagia were offered this food over a 12-week period a significant improvement was observed in their energy intake (+ 600kcal) and weight (+ nearly 4kg) from baseline (108). This study demonstrated that with careful planning and execution, texture modified foods can have an improved appearance, which can result in better nutritional intake by residents in RAC facilities.

(iv) Mealtime ambience: In the RAC setting, meal ambience, delivery method, choice over the meals and overall diet liberalisation may promote appetite and thereby have a significant impact upon the total dietary intake of residents (14, 90, 112). A Dutch cluster randomised, controlled trial revealed that when meals were provided “family style”, energy intake improved by 991kJ (95%CI: 504-1479kJ), which was both statistically and clinically significant, leading to an improvement in global nutritional status (112). Other successful strategies to promote mealtime ambience include restaurant style seating and involving the residents in cooking the meals on the ward (51).

7.2 Evidence for the use of oral nutritional supplements in the RAC setting

The provision of ONS has shown to significantly improve energy and protein intake beyond that provided by a regular or high energy-high protein diet (113, 114). Although ONS consumption may decrease the total amount of energy and protein consumed by meals and snacks, the supplements still result in an overall increased energy and protein intake in malnourished RAC residents (114, 115).

The provision of ONS in the RAC setting has shown to be effective in promoting weight gain and mid-arm and calf circumference and health-related quality of life in residents at risk or malnourished, and therefore may improve nutrition status in malnourished groups (17, 116-119). Only one study reported an improvement in global nutrition status with the provision of ONS (119); however, it must be acknowledged that very few studies have included global nutrition status as an outcome (17). Although some ONS interventions have shown improvements in physical function (17, 119, 120), others have shown no improvement in physical function unless ONS was combined with resistance training (116, 121, 122). Physical activity combined with ONS and oral care was also shown to have additional beneficial effects on social engagement in one study (122).

Resident adherence in consuming ONS is positively associated with improvements in nutritional parameters, such as weight and mid-arm circumference (118, 123). Adherence

has been found to improve when ONS is provided as a nutrient dense, low volume option, of approximately 50 - 125ml with accompanying dietary counselling (116, 118, 123). Adherence is also shown to be higher in residents who are malnourished or have chewing difficulties, but lower in residents who are depressed, are immobile or report gastrointestinal distress, indicating residents with these characteristics will require increased individualised support (118).

Residents with dementia present a unique challenge in the treatment of malnutrition due to increased difficulty with ONS adherence. A 2010 systematic review found that residents with dementia had increased levels of adherence when they received the ONS as part of medication rounds, between meals, and when they received encouragement by carers (124). However, carer compliance with providing the prescribed ONS was still found to be a significant problem (124). Although there is limited research into the health-related outcomes of ONS prescription in RAC residents with dementia, some studies have shown an improvement in weight status and nutrition status (124), which aligns with findings in the general RAC population.

Overall, evidence suggests that individualised ONS in low volumes (50-125ml) may be effective in treating malnutrition in residents by promoting weight gain and resident adherence (116, 118). Oral nutrition supplements may prevent a decrease in physical function, but should be used in combination with resistance exercise in frail residents (17, 115, 119-121). Measures to increase adherence will significantly improve the resident outcomes as well as decrease waste, especially in residents with dementia (118, 120, 124). These findings further emphasise the need for policy which promotes regular malnutrition screening and nutrition assessment of residents, so that intervention can be needs-based.

7.3 Evidence for the use of enteral and parenteral nutrition in the RAC setting

Few studies have investigated the efficacy of enteral nutrition in the RAC setting for the purpose of preventing or treating malnutrition, despite a large number of residents having a feeding tube (125). One study found that dysphagic residents (predominately with dementia) who were fed by percutaneous endoscopic gastrostomy (PEG) were more likely to have a low BMI but failed to have anthropometric improvement with PEG feeding despite increased energy and protein intake compared with orally-fed dysphagic residents (126). Although biochemical nutritional parameters improved, the findings suggest the need for enteral nutrition to be combined with physical activity in order to improve body composition (126). Conversely, an earlier study showed that residents with

dementia who received enteral nutrition had a significant improvement in weight; however, were also more likely to have aspiration pneumonia (127). No intervention studies were identified which examined the role of parental nutrition for the prevention or treatment of malnutrition in the RAC setting.

It can be argued that all older adults admitted to RAC facilities are at risk of malnutrition in the long term, and there may be a cost-benefit to the RAC facilities to provide a liberalised, prophylactic, high energy-high protein diet as the standard menu, as this may prevent the significant costs associated with malnutrition and/or frailty (107, 128, 129). Although little research has been done into the cost-effectiveness of nutritional interventions in RAC, a Dutch study showed that the cost of managing a resident at risk of malnutrition was an additional €8,200 (USD\$8,800), and an additional €10,500 (USD\$11,300) for a malnourished resident per year (130). Conversely, the provision of a high energy-high protein diet via food fortification was found to cost €40 (USD\$43) per resident per year in Sweden (104).

8. Implications for practice and future research

A collaborative multidisciplinary approach to developing effective and systematic strategies that help with identifying, diagnosing and treating malnutrition is imperative to the management of malnutrition in the RAC setting (131). Adequate staffing along with provision of nutrition education, support and adequate time allowance for offering daily care must be given due consideration by policy makers and government authorities (9).

It is imperative to have a consistent approach when defining malnutrition in the RAC setting as this will prevent the issue of potential misdiagnosis and facilitate improved correlation between effective nutritional interventions and health-related outcomes thereby influencing advocacy for the development and implementation of suitable policies, regulations and legislations (38). Residents found to be at risk of malnutrition should undergo comprehensive nutrition assessment by a dietitian or physician. A dietitian is ideally placed to provide nutrition assessment and individualised nutrition intervention due to not only their expertise in malnutrition, but also because many physicians in the RAC setting have insufficient time to dedicate solely to developing and implementing a nutrition care plan. However, in an RAC setting, the nutrition care plan involving a multidisciplinary team is critical for resident improvement, and should involve the dietitian, physician, carers and physical therapists.

There is evidence to suggest that in RAC residents, although the volume of intake at main meals remains unchanged regardless of menu type, energy intake is 50% higher with enriched meals Odlund Olin (104). To increase the energy density of meals, fat is usually added for its higher per gram energy content (37kJ/g) in comparison to protein (17kJ/g) and carbohydrate (16kJ/g). While fat has a lower degree for satiety per calorie, it has the ability to improve food palatability and acceptance, reinforcing the idea that low-volume, energy dense foods are a valid strategy to increase energy intake without affecting appetite in older adults. The provision of a high energy and high protein liberalised diet as the standard menu is likely to improve the nutrition status and quality of life of the resident. However, these enriched meals should be provided in a manner which increases meal ambience, meal quality and resident choice in order to increase dietary intake and reduce waste, thereby also contributing to the prevention and possibly treatment of malnutrition. Oral nutritional supplements will help to improve the weight status and health-related quality of life in some malnourished residents, but should be combined with resistance exercise in frail older adults to improve physical function. Furthermore, strategies should be employed to increase staff and resident adherence with ONS, which will improve resident outcomes as well as cost-effectiveness. The evidence for enteral nutrition as a method of malnutrition treatment in RAC residents is controversial and insufficient, and no studies have examined the role of parental nutrition.

Since malnutrition is associated with inadequate nutritional intake, and given its high prevalence in the RAC setting, it can be concurred that food availability in RAC facilities is not synonymous with food security for RAC residents (64). However, this aspect has not been well documented in the literature and offers scope for further investigation in the RAC setting, particularly in residents with various forms of cognitive impairment.

Further research is required to examine the role of residents and their family members/carers having a greater input into food, improved meal time ambience combined with a prophylactic high energy-high protein liberalised diet and a nutrition coordinator in the prevention and treatment of malnutrition. Evidence is also required for the cost-effectiveness and acceptability of nutrition interventions, with an emphasis on improving compliance and minimising food insecurity. Furthermore, to improve the quality of evidence available, nutrition interventions should report outcomes on global nutrition status as determined by a validated method of nutrition assessment in this setting.

9. Conclusion

Unfortunately malnutrition remains unacceptably high in the RAC setting, with at least half the RAC population at risk of developing malnutrition and approximately one-in-three residents assessed as malnourished. Identifying and managing malnutrition in the RAC setting will not only likely improve associated health-related outcomes for individual residents but also possibly extend to benefitting the institutions and health care system economically. Although nutritional interventions which modify the method of food provision and/or provide ONS have demonstrated better outcomes for at risk and malnourished aged care residents, further research is required to improve the evidence base and inform aged care policy.

Contributors

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Conflict of interest

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Figure 1: Aetiology of malnutrition in the elderly (Adapted from 15, 33)

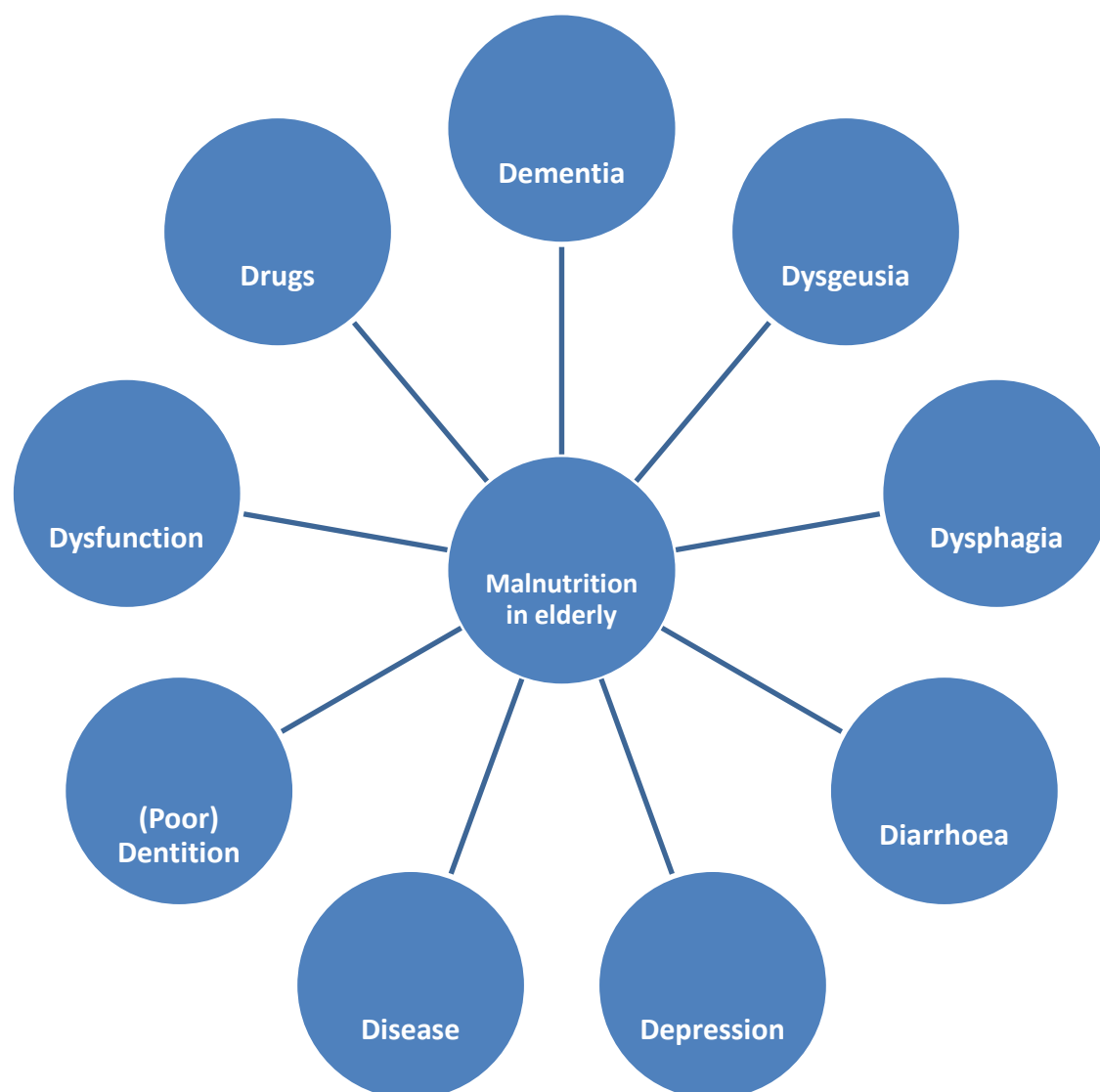


Table 1: Cause and consequences of malnutrition (Compiled from 32, 38, 52, 71-75, 79, 80, 87, 102, 132-134)

Cause	Consequence
Physiological	
Impaired immune response	Increased susceptibility to infection and impaired recovery from infection
Impaired wound healing	Surgical wound dehiscence, anastomotic breakdowns, post-surgical fistulae
Reduced muscle mass and strength	Limited physical function, increased disability, increased risk of falls, pressure ulcers, decreased activity leading to increased risk of thromboembolism
Reduced subcutaneous fat for cushioning	Increased risk of fractures in accidents, falls
Reduced respiratory function	Poor cough pressure, increased susceptibility to respiratory infection, fatigue, poor breathing control, pulmonary oedema
Water and electrolyte imbalances	Depletion of potassium, magnesium and phosphate stores combined with excess sodium and water leading to increased risk of re-feeding syndrome and iatrogenic sodium and water overload
Impaired thermoregulation	Hypothermia and increased risk of falls
Vitamin and mineral deficiencies	Specific deficiency states including scurvy and Wernicke-Korsakoff syndrome, iron-deficiency and pernicious anaemia or magnesium deficiency
Reduced hepatic function	Anaemia, fatigue, oedema
Reduced cardiac muscle	Decreased cardiac output
	Mortality
Psychosocial	
Lower quality of life	Apathy, depression, self-neglect, hypochondriasis, poor self-efficacy, poor body image, confusion, decreased interest in food, loss of libido, less engagement in social activities due to the overall physiological burden of malnutrition

Appendix VI

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Appendix VII

The Mini Nutritional Assessment (MNA) encompassing the Mini Nutritional Assessment-Short Form (MNA-SF) (Guigoz et al., 1997). Reproduced with permission of Nestlé (appendix IX)



Mini Nutritional Assessment MNA®

Last name:		First name:		
Sex:	Age:	Weight, kg:	Height, cm:	Date:

Complete the screen by filling in the boxes with the appropriate numbers. Add the numbers for the screen. If score is 11 or less, continue with the assessment to gain a Malnutrition Indicator Score.

<p>Screening</p> <p>A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties? 0 = severe decrease in food intake 1 = moderate decrease in food intake 2 = no decrease in food intake <input type="checkbox"/></p> <p>B Weight loss during the last 3 months 0 = weight loss greater than 3kg (6.6lbs) 1 = does not know 2 = weight loss between 1 and 3kg (2.2 and 6.6 lbs) 3 = no weight loss <input type="checkbox"/></p> <p>C Mobility 0 = bed or chair bound 1 = able to get out of bed / chair but does not go out 2 = goes out <input type="checkbox"/></p> <p>D Has suffered psychological stress or acute disease in the past 3 months? 0 = yes 2 = no <input type="checkbox"/></p> <p>E Neuropsychological problems 0 = severe dementia or depression 1 = mild dementia 2 = no psychological problems <input type="checkbox"/></p> <p>F Body Mass Index (BMI) (weight in kg) / (height in m²) 0 = BMI less than 19 1 = BMI 19 to less than 21 2 = BMI 21 to less than 23 3 = BMI 23 or greater <input type="checkbox"/></p> <p>Screening score <input type="checkbox"/><input type="checkbox"/> (subtotal max. 14 points)</p> <p>12-14 points: Normal nutritional status 8-11 points: At risk of malnutrition 0-7 points: Malnourished</p> <p>For a more in-depth assessment, continue with questions G-R</p> <p>Assessment</p> <p>G Lives independently (not in nursing home or hospital) 1 = yes 0 = no <input type="checkbox"/></p> <p>H Takes more than 3 prescription drugs per day 0 = yes 1 = no <input type="checkbox"/></p> <p>I Pressure sores or skin ulcers 0 = yes 1 = no <input type="checkbox"/></p>	<p>J How many full meals does the patient eat daily? 0 = 1 meal 1 = 2 meals 2 = 3 meals <input type="checkbox"/></p> <p>K Selected consumption markers for protein intake</p> <ul style="list-style-type: none"> • At least one serving of dairy products (milk, cheese, yoghurt) per day yes <input type="checkbox"/> no <input type="checkbox"/> • Two or more servings of legumes or eggs per week yes <input type="checkbox"/> no <input type="checkbox"/> • Meat, fish or poultry every day yes <input type="checkbox"/> no <input type="checkbox"/> <p>0.0 = if 0 or 1 yes 0.5 = if 2 yes 1.0 = if 3 yes <input type="checkbox"/> . <input type="checkbox"/></p> <p>L Consumes two or more servings of fruit or vegetables per day? 0 = no 1 = yes <input type="checkbox"/></p> <p>M How much fluid (water, juice, coffee, tea, milk...) is consumed per day? 0.0 = less than 3 cups 0.5 = 3 to 5 cups 1.0 = more than 5 cups <input type="checkbox"/> . <input type="checkbox"/></p> <p>N Mode of feeding 0 = unable to eat without assistance 1 = self-fed with some difficulty 2 = self-fed without any problem <input type="checkbox"/></p> <p>O Self view of nutritional status 0 = views self as being malnourished 1 = is uncertain of nutritional state 2 = views self as having no nutritional problem <input type="checkbox"/></p> <p>P In comparison with other people of the same age, how does the patient consider his / her health status? 0.0 = not as good 0.5 = does not know 1.0 = as good 2.0 = better <input type="checkbox"/> . <input type="checkbox"/></p> <p>Q Mid-arm circumference (MAC) in cm 0.0 = MAC less than 21 0.5 = MAC 21 to 22 1.0 = MAC 22 or greater <input type="checkbox"/> . <input type="checkbox"/></p> <p>R Calf circumference (CC) in cm 0 = CC less than 31 1 = CC 31 or greater <input type="checkbox"/></p> <p>Assessment (max. 16 points) <input type="checkbox"/><input type="checkbox"/> . <input type="checkbox"/></p> <p>Screening score <input type="checkbox"/><input type="checkbox"/> . <input type="checkbox"/></p> <p>Total Assessment (max. 30 points) <input type="checkbox"/><input type="checkbox"/> . <input type="checkbox"/></p>
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Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. Screening for Undernutrition in Geriatric Practice: Developing the Short-Form Mini Nutritional Assessment (MNA-SF). J Gerontol 2001; 56A: M366-377.
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Malnutrition Indicator Score

24 to 30 points	<input type="checkbox"/>	normal nutritional status
17 to 23.5 points	<input type="checkbox"/>	at risk of malnutrition
Less than 17 points	<input type="checkbox"/>	malnourished

Appendix VIII

A poster titled “Malnutrition, is your patient at risk?” produced by the Queensland Government which outlines and describes the Malnutrition Screening Tool (MST) (Ferguson et al., 1999b). Reproduced with permission of M. Banks.

Malnutrition

Is your patient at risk?

Malnutrition Screening Tool¹ (MST)

1. Have you/the patient lost weight recently without trying?		<p>Applies to the last six months</p> <p>If unsure, ask if they suspect they have lost weight - eg, clothes are looser</p> <p>For example, less than three-quarters of usual intake may also be eating poorly due to chewing and swallowing problems</p> <p>Of weight loss and appetite questions</p>
No	0	
Unsure	2	
Yes, how much (kg)?		
1 – 5	1	
6 – 10	2	
11 – 15	3	
> 15	4	
Unsure	2	
2. Have you/the patient been eating poorly because of a decreased appetite?		
No	0	
Yes	1	
Total Score		

Score 2 or more

If your patients have lost weight and/or are eating poorly - ie, score two or more, or they are very underweight, then they may be at risk of malnutrition.



Malnutrition occurs in approximately 30–40% of acute and 50% of residential patients in Queensland Health Institutions²

Action

1. Refer to Malnutrition Action Flowchart and/or refer to Dietitian for full assessment and intervention
2. Document
3. Weigh patient's on admission and:
 - (a) weekly (acute)
 - (b) monthly (long-term care)
4. Re-screen patients:
 - (a) weekly (acute)
 - (b) monthly (long-term care)

Small weekly weight losses add up to significant weight loss and malnutrition

Note: Overweight/obese residents who have unexplained weight loss and illness can become protein depleted/malnourished too

Appendix IX

Appendix of the Scored Patient-Generated Subjective Global Assessment (PG-SGA) from the Use of the scored Patient-Generated Subjective Global Assessment (PG-SGA) as a nutrition assessment tool in patients with cancer (Bauer et al., 2002), originally produced by Ottery (Ottery, 2000).



Use of the PG-SGA
Bauer et al

784

Appendix

Scored Patient-Generated Subjective Global Assessment (PG-SGA)

History (Boxes 1-4 are designed to be completed by the patient.)

1. Weight (See Worksheet 1)

In summary of my current and recent weight:

I currently weigh about _____ kg

I am about _____ cm tall

One month ago I weighed about _____ kg

Six months ago I weighed about _____ kg

During the past two weeks my weight has:

☐ decreased ⁽¹⁾ ☐ not changed ⁽⁰⁾ ☐ increased ⁽⁰⁾

Box 1

2. Food Intake: As compared to my normal intake, I would rate my food intake during the past month as:

- ☐ unchanged ⁽⁰⁾
☐ more than usual ⁽⁰⁾
☐ less than usual ⁽¹⁾
 I am now taking:
☐ normal food but less than normal amount ⁽¹⁾
☐ little solid food ⁽²⁾
☐ only liquids ⁽³⁾
☐ only nutritional supplements ⁽³⁾
☐ very little of anything ⁽⁴⁾
☐ only tube feedings or only nutrition by vein ⁽⁰⁾

Box 2

3. Symptoms: I have had the following problems that have kept me from eating enough during the past two weeks (check all that apply):

- ☐ no problems eating ⁽⁰⁾
☐ no appetite, just did not feel like eating ⁽³⁾
☐ nausea ⁽¹⁾ ☐ vomiting ⁽³⁾
☐ constipation ⁽¹⁾ ☐ diarrhea ⁽³⁾
☐ mouth sores ⁽²⁾ ☐ dry mouth ⁽¹⁾
☐ things taste funny or have no taste ⁽¹⁾ ☐ smells bother me ⁽¹⁾
☐ problems swallowing ⁽²⁾ ☐ feel full quickly ⁽¹⁾
☐ pain; where? ⁽³⁾ _____
☐ other** ⁽¹⁾ _____

** Examples: depression, money, or dental problems

Box 3

4. Activities and Function: Over the past month, I would generally rate my activity as:

- ☐ normal with no limitations ⁽⁰⁾
☐ not my normal self, but able to be up and about with fairly normal activities ⁽¹⁾
☐ not feeling up to most things, but in bed or chair less than half the day ⁽²⁾
☐ able to do little activity and spend most of the day in bed or chair ⁽³⁾
☐ pretty much bedridden, rarely out of bed ⁽³⁾

Box 4

Additive Score of the Boxes 1-4 A

The remainder of this form will be completed by your doctor, nurse, or therapist. Thank you.

5. Disease and its relation to nutritional requirements (See Worksheet 2)

All relevant diagnoses (specify) _____

Primary disease stage (circle if known or appropriate) I II III IV Other _____

Age _____

Numerical score from Worksheet 2 B

6. Metabolic Demand (See Worksheet 3)

Numerical score from Worksheet 3 C

7. Physical (See Worksheet 4)

Numerical score from Worksheet 4 D

Global Assessment (See Worksheet 5)

- ☐ Well-nourished or anabolic (SGA-A)
☐ Moderate or suspected malnutrition (SGA-B)
☐ Severely malnourished (SGA-C)

Total PG-SGA score

(Total numerical score of A+B+C+D above)
 (See triage recommendations below)

Clinician Signature _____ RD RN PA MD DO Other _____ Date _____

Nutritional Triage Recommendations: Additive score is used to define specific nutritional interventions including patient & family education, symptom management including pharmacologic intervention, and appropriate nutrient intervention (food, nutritional supplements, enteral, or parenteral triage). First line nutrition intervention includes optimal symptom management.

0-1 No intervention required at this time. Re-assessment on routine and regular basis during treatment.

2-3 Patient & family education by dietitian, nurse, or other clinician with pharmacologic intervention as indicated by symptom survey (Box 3) and laboratory values as appropriate.

4-8 Requires intervention by dietitian, in conjunction with nurse or physician as indicated by symptoms survey (Box 3).

≥ 9 Indicates a critical need for improved symptom management and/or nutrient intervention options.

Worksheets for PG-SGA Scoring

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Boxes 1-4 of the PG-SGA are designed to be completed by the patient. The PG-SGA numerical score is determined using 1) the parenthetical points noted in boxes 1-4 and 2) the worksheets below for items not marked with parenthetical points. Scores for boxes 1 and 3 are additive within each box and scores for boxes 2 and 4 are based on the highest scored item checked off by the patient.

Worksheet 1 - Scoring Weight (Wt) Loss

To determine score, use 1 month weight data if available. Use 6 month data only if there is no 1 month weight data. Use points below to score weight change and add one extra point if patient has lost weight during the past 2 weeks. Enter total point score in Box 1 of the PG-SGA.

Wt loss in 1 month	Points	Wt loss in 6 months
10% or greater	4	20% or greater
5-9.9%	3	10-19.9%
3-4.9%	2	6-9.9%
2-2.9%	1	2-5.9%
0-1.9%	0	0-1.9%

Score for Worksheet 1
Record in Box 1

Worksheet 2 - Scoring Criteria for Condition

Score is derived by adding 1 point for each of the conditions listed below that pertain to the patient.

Category	Points
Cancer	1
AIDS	1
Pulmonary or cardiac cachexia	1
Presence of decubitus, open wound, or fistula	1
Presence of trauma	1
Age greater than 65 years	1

Score for Worksheet 2 =
Record in Box B

Worksheet 3 - Scoring Metabolic Stress

Score for metabolic stress is determined by a number of variables known to increase protein & calorie needs. The score is additive so that a patient who has a fever of > 102 degrees (3 points) and is on 10 mg of prednisone chronically (2 points) would have an additive score for this section of 5 points.

Stress	none (0)	low (1)	moderate (2)	high (3)
Fever	no fever	>99 and <101	≥101 and <102	≥102
Fever duration	no fever	<72 hrs	72 hrs	> 72 hrs
Steroids	no steroids	low dose (<10mg prednisone equivalents/day)	moderate dose (≥10 and <30mg prednisone equivalents/day)	high dose steroids (≥30mg prednisone equivalents/day)

Score for Worksheet 3 =
Record in Box C

Worksheet 4 - Physical Examination

Physical exam includes a subjective evaluation of 3 aspects of body composition: fat, muscle, & fluid status. Since this is subjective, each aspect of the exam is rated for degree of deficit. Muscle deficit impacts point score more than fat deficit. Definition of categories: 0 = no deficit, 1+ = mild deficit, 2+ = moderate deficit, 3+ = severe deficit. Rating of deficit in these categories are *not* additive but are used to clinically assess the degree of deficit (or presence of excess fluid).

Fat Stores:

orbital fat pads	0	1+	2+	3+
triceps skin fold	0	1+	2+	3+
fat overlying lower ribs	0	1+	2+	3+
Global fat deficit rating	0	1+	2+	3+

Muscle Status:

temples (temporalis muscle)	0	1+	2+	3+
clavicles (pectoralis & deltoids)	0	1+	2+	3+
shoulders (deltoids)	0	1+	2+	3+
interosseous muscles	0	1+	2+	3+
scapula (latissimus dorsi, trapezius, deltoids)	0	1+	2+	3+
thigh (quadriceps)	0	1+	2+	3+
calf (gastrocnemius)	0	1+	2+	3+
Global muscle status rating	0	1+	2+	3+

Fluid Status:

ankle edema	0	1+	2+	3+
sacral edema	0	1+	2+	3+
ascites	0	1+	2+	3+
Global fluid status rating	0	1+	2+	3+

Point score for the physical exam is determined by the overall subjective rating of total body deficit.

No deficit	score = 0 points
Mild deficit	score = 1 point
Moderate deficit	score = 2 points
Severe deficit	score = 3 points

Score for Worksheet 4 =
Record in Box D

Worksheet 5 - PG-SGA Global Assessment Categories

	Stage A Well-nourished	Stage B Moderately malnourished or suspected malnutrition	Stage C Severely malnourished
Weight	No wt loss OR Recent non-fluid wt gain	~5% wt loss within 1 month (or 10% in 6 months) OR No wt stabilization or wt gain (i.e., continued wt loss)	> 5% wt loss in 1 month (or >10% in 6 months) OR No wt stabilization or wt gain (i.e., continued wt loss)
Nutrient Intake	No deficit OR Significant recent improvement	Definite decrease in intake	Severe deficit in intake
Nutrition Impact Symptoms	None OR Significant recent improvement allowing adequate intake	Presence of nutrition impact symptoms (Box 3 of PG-SGA)	Presence of nutrition impact symptoms (Box 3 of PG-SGA)
Functioning	No deficit OR Significant recent improvement	Moderate functional deficit OR Recent deterioration	Severe functional deficit OR recent significant deterioration
Physical Exam	No deficit OR Chronic deficit but with recent clinical improvement	Evidence of mild to moderate loss of SQ fat &/or muscle mass &/or muscle tone on palpation	Obvious signs of malnutrition (e.g., severe loss of SQ tissues, possible edema)

Global PG-SGA rating (A, B, or C) =

Appendix X

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January 9, 2016

Skye Marshall
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Kaiser MJ, Bauer JM, Ramsch C, et al. Validation of the Mini Nutritional Assessment Short-Form (MNA[®]-SF): A practical tool for identification of nutritional status. *J Nutr Health Aging* 2009; 13:782-788.

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Appendix XIII

Recognition and media coverage of research

Media coverage and special recognition of the research presented in this thesis (not shown)

1. As a result of the recognition of publications generated during the PhD candidature, Skye Marshall has provided peer review for a number of malnutrition-related papers submitted to peer-reviewed journals, including:
 - i. Journal of the American Geriatrics Society (IF=3.842)
 - ii. Journal of the Academy of Nutrition and Dietetics (IF=3.609)
 - iii. The Journal of Nutrition, Health & Aging (IF=2.996)
 - iv. Nutrition Journal (IF=3.265)
 - v. Clinical Interventions in Aging (IF=2.133)
 - vi. Journal of Public Health (IF=2.019)
 - vii. Journal of Advanced Nursing (IF=1.917)
 - viii. Pilot and Feasibility Studies (IF=N/A)
2. Editorial in “Ageless” magazine regarding the role of informal caregivers of malnourished older adults in the community
3. Webinar “Protein-Energy Malnutrition: Examining the pathophysiology and burden of malnutrition in the 2010s”, presented by Bond University, to be shared by Education in Nutrition and Dietitian Connection. Prepared by Skye Marshall as a sole author.
4. Report by Alzheimer’s Australia NSW: Miskovski, K. (2015) Dementia and Nutrition in the Home, Alzheimer’s Australia NSW Discussion Paper 14, November 2015. URL:
library.bsl.org.au/jspui/bitstream/1/7776/1/MiskovskiK_Dementia_and_nutrition_in_the_home_Alzheimers_Australia-2015.pdf

Media coverage and special recognition of the research presented in this thesis, which is shown in the following pages

1. Media release from the DAA to promote the 30th National Conference, titled *Nutrition leaders celebrate Canberra’s centenary*.
2. Certificate for “Best of the best” oral presentation from the 30th DAA National Conference, awarded to PhD candidates with outstanding abstracts.
3. Bond University Three Minute Thesis Competition entry: “Superheros of the nutrition team” static poster.
4. Bond University Three Minute Thesis Competition: 2015 Runner-Up certificate.

5. Media release from Bond University regarding the research by the Three Minute Thesis winners.
6. Best Oral Presentation certificate at Bond University Faculty of Health Sciences and Medicine Higher Degree Research Conference, 2015.

21 MAY 2013

Nutrition leaders celebrate Canberra's centenary

As Canberra celebrates its 100th birthday, Australia's leading nutrition experts will gather in the nation's capital from 23-25 May to focus on important issues facing the future health of this country, including population ageing, food security and environmental sustainability.

More than 500 dietitians, nutritionists and nutrition science researchers from around Australia are attending the event, which is being hosted by the nation's peak nutrition body, the Dietitians Association of Australia (DAA).

Held in Canberra during its Centenary year, DAA President, Julie Dundon says Canberra was an ideal location to celebrate the 30th DAA National Conference, themed 'Reflection for the challenges of tomorrow'.

'I am thrilled to be able to celebrate our country's proud history. This is a perfect time and place for our nutrition leaders to look back on what has been achieved in the health and nutrition arena.

'But we must keep our eyes looking to the future, as there are big health and nutrition challenges that we must face if we want a healthy nation in centuries to come.

Ms Dundon says the Australian demographic is changing, and Australia needs to be prepared for the health consequences.

According to latest figures, the number of Australians over the age of 65 years is expected to more than double in the next 30 years¹. And Australia's largest food relief agency Foodbank reports a staggering 2.2 million Australians are now living in poverty².

'Australia is a lucky country. But in the face of too much food and skyrocketing rates of obesity, we often forget about the many vulnerable groups who are still suffering from lack of food.'

New research presented at the conference will reveal almost half of residents in the community who receive home nursing services are malnourished, or at risk of malnutrition³.

'We cannot neglect the health of our older Australians. Malnutrition can be treated and prevented with the right tools in place, such as a national screening program,' says Ms Dundon.

Results from a systematic review on malnutrition will be presented at the conference; which demonstrates targeted nutrition intervention delivered in the home can improve and prevent decline in nutritional status of older Australians living in the community⁴.

‘Keeping all Australians healthy, with access to nutritious food, is a top priority for dietitians. By working with Government and other organisations, dietitians can help ensure a healthy diet, and sustainable food supply that prevents chronic disease, obesity and malnutrition,’ says Ms Dundon.

ENDS

For further information on the research being presented at the conference, or to request a press pass, please contact Holly Smith, Dietitians Association of Australia on 0408 482 581.

Note to Editors: The Dietitians Association of Australia (DAA) is the professional body representing dietitians nationally. Accredited Practising Dietitian (APD) is the only national credential recognised by the Australian Government, Medicare, the Department of Veterans Affairs and most private health funds as the quality standard for nutrition and dietetics services in Australia. For more information visit www.daa.asn.au The [Media Centre](#) on the DAA website contains DAA’s Media Releases and positions on topical nutrition issues in the media.

Background:

30th Dietitians Association of Australia National Conference

When: Thursday 23 – Saturday 25 May, 2013

Where: National Convention Centre, Canberra, ACT

Many key health and nutrition issues are on the menu, including:

- Overweight and obesity
- Malnutrition
- Food security
- Environmental sustainability.

Visit the official conference website for the program and list of national and international speakers: www.arinex.com.au/dietitians2013/program/

Press passes

Be onsite for the conference to attend sessions and interview speakers. Press passes can be made available for interested media (including Australian-based journalists from print, radio, television and online media outlets) to attend sessions at the conference. To request a press pass, please email Holly Smith at hsmith@daa.asn.au

Please note. Issuing of press passes is at the discretion of the Conference Planning Committee.

On-site media centre

Interested journalists can use the dedicated on-site media centre, which will be set up with work stations, a phone line, an interview space, and copies of speaker’s abstracts.

The media centre opens at 8am on Thursday 23 May for the duration of the conference. Staff from the Dietitians Association of Australia will be on hand to assist with coordinating interviews with speakers and accessing additional information.

¹ Department of Health and Ageing, Living Longer. Living Better. Available at: <http://www.health.gov.au/internet/publications/publishing.nsf/Content/ageing-aged-care-reform-measures-toc~ageing-aged-care-reform-measures-chapter2.htm>

² Foodbank. The Facts. Available at: <http://www.foodbank.org.au/hunger-in-australia/the-endhunger-report/>

³ Forbes, C et al. ‘Incidence of malnutrition and associated issues in community-living older adults accessing community nursing services in a rural area.’

⁴ Marshall, S et al. ‘Are informal carers and community care workers effective in managing malnutrition in the older adult community? A systematic review of current evidence.’



DAA 30th National Conference Canberra 2013

Highly Commended
in 'Best of the Best' session

for paper

Are informal carers and community care workers effective
in managing malnutrition in the older adult community? A
systemic review of current evidence

presented to

Skye Marshall

Dated 25 May 2013

President





Family and friends of malnourished older adults – Superheros of the nutrition team?



**BOND
UNIVERSITY**

3 Minute Thesis Competition 2015 Runner~Up

Prize: \$1000 for travel relating to your thesis

.....
Professor Rick Bigwood

2 September 2015

10 September 2015

Texting study gets message across quickly

After years of studying texting and romantic relationships, Jodie Bradnam knows better than most how to get a message across quickly, and it has earned her top honours in Bond University's Three Minute Thesis (3MT) competition.

The psychology student presented her latest findings into whether texting fosters relationship intimacy at the competition, which challenges students to describe their research within three minutes to a general audience. Jodie was awarded both overall winner and people's choice.

Jodie's research findings revealed that while the use of text messaging in young adult relationships could enhance intimacy, using text messaging to manage conflict and communicate hostility was strongly related to declines in relationship satisfaction.

Jodie will now compete in the 2015 Trans-Tasman 3MT Competition against students from around Australia and New Zealand, being held at The University of Queensland (UQ) on October 2, 2015.

Jodie said she had been working on her thesis since 2012 - titled 'Text messaging, attachment orientation, satisfaction and stability in romantic relationships: Does texting foster relationship intimacy?' - which explored the links between romantic attachment, texting and relationship quality.

More than 990 young adults have already taken part in the study, with the final phase of research involving a further 200 young adult couples about to begin.

She said mobile phones had significantly changed the way romantic partners communicate and the research had already uncovered some interesting findings.

"Young people, aged 18 to 30, are the largest adult users of text messaging. Young adults send up to 90 text messages each day and texting is a way of staying connected," said Jodie.

"While emerging research suggests text messaging may be a tool for promoting intimacy and connection in young romantic relationships, we've also found the use of texting for the management of conflict has been associated with significant reductions in relationship quality.

"What we've found is that a strong, positive, emotional climate is required to buffer the impact of negative text message sent between partners.

"The next phase of the research will involve couples so we can study the effect of text messaging on relationship quality from the perspective of each partner."

Nutrition and dietetics student Skye Marshall was named runner-up for her presentation, covering

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her research into the role of family and friends in the rehabilitation of older malnourished patients. Skye said her research involved 57 adults aged 65 or older who were admitted to rural rehabilitation wards, 46% of whom had malnutrition, and whether those supported by 'informal caregivers' such as family and friends improved their condition in the long term after they had returned home.

"What we've found is that family and friends aren't being adequately engaged in their care and, as a result, overwhelmingly they were still malnourished three months later," she said.

"I'm doing the final piece of research now to complete the study, which will involve interviewing family and friends to create recommendations for how to better engage them to achieve more positive outcomes."

Bond University Director of Research Services Mr Andrew Calder said the competition was a great way to showcase the diverse research underway at Bond, and right around Australia and New Zealand.

"Jodie and Skye are examples of the vast array of research being undertaken, with studies at Bond covering everything from food security to stalking and sustainable planning," he said.

"The Three Minute Thesis competition allows young researchers to engage with the wider community and showcase the work currently underway that will ultimately help to improve the way we do things."

Mr Calder said Bond University was looking for aspiring researchers to join the growing research team, with PhD scholarships now on offer to bolster the diverse studies underway by Bond's Higher Degree by Research (HDR) community. Applications for scholarships close September 30, 2015.

ENDS

Best Oral Presentation

awarded to

SKYE MARSHALL

at the

**Faculty of Health Sciences & Medicine
Higher Degree Research Conference 2015**

Bond University, Gold Coast, Queensland

18th November 2015

Dr Donna Sellers
Associate Dean (Research)

End of thesis.